COVIDIEN

Service Manual

ForceTriad™

Energy Platform

Service Manual

ForceTriad™

Energy Platform

Part Number: 1040472

Preface

This manual and the equipment it describes are for use only by qualified personnel trained in the particular technique and surgical procedure to be performed. It is intended as a guide for servicing the Covidien ForceTriad energy platform only. Additional users information is available in the *ForceTriad Energy Platform User's Guide*.

Additional technical information may be available from Covidien Technical Service (see page 9-4).

For a complete list of service centers world wide, please refer to the Covidien web site: http://www.valleylab.com

Equipment covered in this manual:
ForceTriad Energy Platform

Conventions Used in this Guide

Warning

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

Notice

Indicates a hazard which may result in product damage.

Important

Indicates *an operating tip or maintenance suggestion.*

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Electrosurgical Generators	One year from date of shipment
Cool-tip™ RFA Generator	One year from date of shipment
Evident™ MWA Generator	One year from date of shipment
LigaSure™ Vessel Sealing System	One year from date of shipment
LigaSure™ Reusable Instruments	One year from date of shipment
Mounting Fixtures (all models)	One year from date of shipment
Footswitches (all models)	One year from date of shipment
Valleylab™ Argon Gas Delivery Unit II	One year from date of shipment
RapidVac™ Smoke Evacuator	One year from date of shipment
LigaSure™ Sterile Single Use Items	Sterility only as stated on packaging
Cool-tip™ Sterile Single Use Items	Sterility only as stated on packaging
Sterile Single Use Items	Sterility only as stated on packaging
Patient Return Electrodes	Shelf life only as stated on packaging
All purchased or supplemental software programs or updates	90 days from delivery

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Table of Contents

Chapter 4. Technical Specifications

Chapter 5. System Setup

Chapter 6. Setup, Tests, and Adjustments

Chapter 7. Troubleshooting

Chapter 8. Replacement Procedures

Chapter 9. Maintenance and Repair

Chapter 10. Service Parts

Chapter 1

Overview and General Features

This chapter provides an overview of the features and functions of the ForceTriad energy platform.

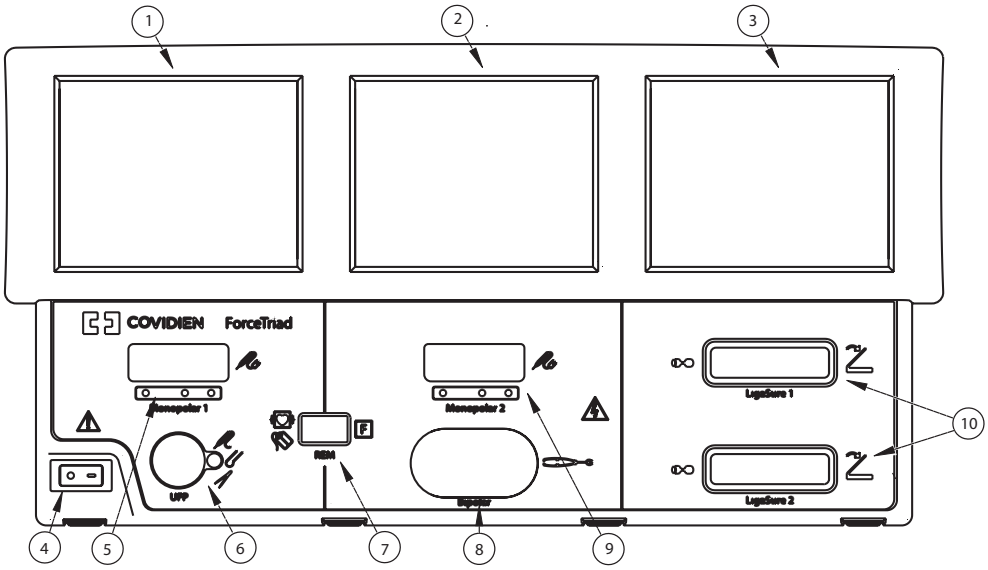
Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Introduction

The ForceTriad energy platform is designed to provide radio frequency (RF) energy for monopolar and bipolar surgical applications and tissue-fusion applications. It features three touchscreen user interfaces, and has the ability to automatically detect handsets and to configure the system accordingly. Safety and diagnostic functionality include automatic fail-safe functions.

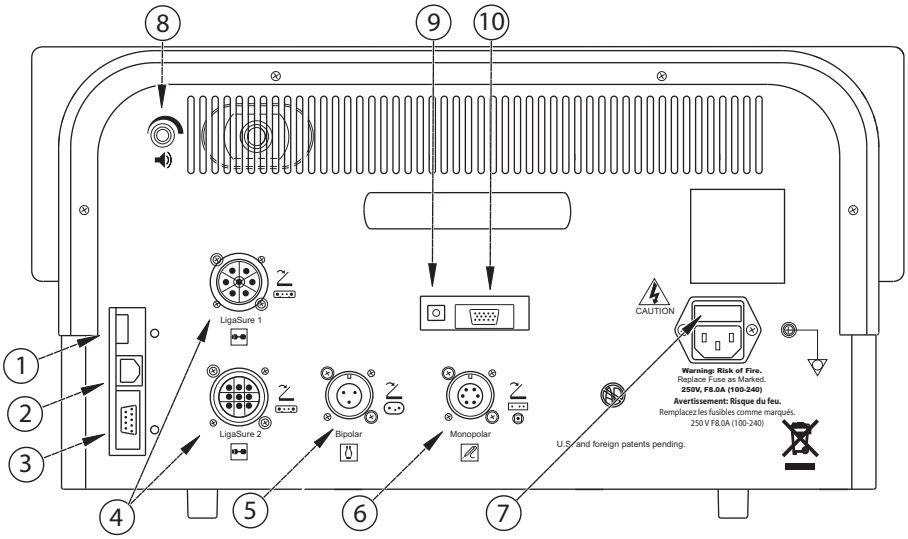
The system is a self-contained unit, consisting of a main enclosure (cover and base) and a power cord. Details about the interaction of the main components and PCBA descriptions are provided in Chapter 3, *Principles of Operation*.

ForceTriad Energy Platform Front Panel



① Monopolar 1 and Accessory Touchscreen
② Monopolar 2 and Bipolar Touchscreen
③ LigaSure and System Tray Touchscreen
④ Power Switch
⑤ Monopolar-Instrument Receptacle
⑥ Universal-Footswitching-Accessory Receptacle
⑦ REM™ Patient Return Electrode Receptacle
⑧ Bipolar-Instrument Receptacle
⑨ Monopolar 2-Instrument Receptacle
⑩ LigaSure 1 and 2 Receptacles

ForceTriad Energy Platform Back Panel



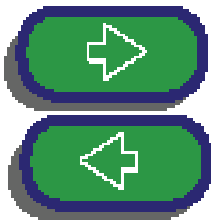
① USB Port
② Ethernet Port
③ RS232 Port
④ LigaSure 1 and 2 Footswitch Port
⑤ Bipolar-Footswitch Receptacle
⑥ Monopolar-Footswitch Receptacle (requires adapter to connect standard four-pin monopolar footswitch)
⑦ Fuse Port
⑧ Audio-Volume Knob
⑨ Link-Cable Port (ECG Receptacle)
⑩ Expansion Port

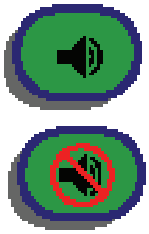
System Conventions

Touchscreens

The ForceTriad energy platform features a user-friendly interface with three touchscreens that allow the user to control system functions. The active touchscreen or touchscreens illuminate, and the unavailable touchscreens dim.

Common Symbols

Symbol	Name	Description
	**Page Up/Page Down**	Scrolls through blocks of options that cannot be displayed on a single screen.
	**Up/Down**	Pressing once increases/decreases the associated value or moves highlighted selection up/down one line. Pressing and holding scrolls up/down.
	**Next/Back**	Progresses to the next screen, or returns to the previous screen.
	**Back Space**	Regresses one character.

Symbol	Name	Description
	**Bipolar Mute On/Off**	Turns on/off the audio tones produced by the system that indicate the increase or decrease of current during a bipolar procedure.
	**Cancel**	Cancels current screen and returns to the previous screen.
	**Enter**	Accepts and initiates current selections.
	**System Tray**	Accesses and adjusts system settings including screen brightness and main-menu options as well as a connection indicator.
	**Brightness**	Each selection of this button alternately adjusts between two available brightness settings. When maximum brightness is reached, next selection resets to the least bright setting.
	**Wrench**	Selects access to the Main Menu, which provides user-selected options for language, appearance, and operation.

Symbol	Name	Description
	**Connection Indicator**	Indicates active communication with another system such as Valleylab Exchange Remote Software System or a third-party system.
	**Errors Disabled**	This icon on a yellow background overlays the screen when error warnings have been disabled using the service menu. The system does not alarm or give error conditions when this symbol is activated. Touching the screen removes the icon for five seconds.

Note: Additional information on symbols may be found in Chapter 4, *Technical Specifications*.

Power Modes

As a safety feature, simultaneous activation of multiple instruments is not possible on the system.

Monopolar Modes

The system produces five modes of power output.

Note: To provide expected hand-piece functionality, proper insertion of the hand piece is required. Refer to the orientation drawing on the front of the system for proper insertion orientation.

Cut Modes

Pure cut provides a clean, precise cut in any tissue with little or no hemostasis.

Blend cut is a conventional blended waveform that provides slower cutting with simultaneous hemostasis.

Valleylab Mode

Valleylab mode is a unique combination of hemostasis and dissection that allows the user to slow down for more hemostasis and speed up for faster dissection. Thermal spread is equal to or less than cut or blend modes.

Coag Modes

Fulgurate coagulates tissue by sparking from the active electrode, through air, to the patient tissue. Because sparks may spray unpredictably from the electrode during fulguration, using fulguration for delicate tissue or in confined areas can complicate surgery. Accidental sparking to adjacent areas can occur as tissue at the surgical site dries and becomes more resistant to current flow.

Spray delivers wider fulguration; penetration is shallower and the affected tissue area is larger than with the Fulgurate mode.

Bipolar Modes

Three bipolar modes are available: low, standard, and macrobipolar.

Low delivers precision and fine control over the amount of desiccation.

Standard is a conventional bipolar output at low voltage.

Macro (macrobipolar) may be used for bipolar cutting or rapid coagulation. Power remains constant over a wide range of tissue types.

Autobipolar

The autobipolar feature senses tissue impedance between the two bipolar electrodes, then uses the impedance information to automatically start or stop bipolar RF energy delivery. Optionally, the user may choose between footswitch start and auto start, or program a delay between auto start and RF activation.

Note: When using autobipolar, the tissue in the grasp of the bipolar device must have an impedance within 20 Ω and 1,000 Ω. The activation impedance safety feature does not deliver RF power to the tissue if it is not within the specified range. This is a factory-set value that cannot be reset by the user.

LigaSure Mode

The LigaSure tissue-fusion mode can be used on arteries, veins, pulmonary vasculature, and lymphatics up to and including 7 mm in diameter and tissue bundles. This system provides precise energy delivery and electrode pressure to vessels for a controlled time period to achieve a complete and permanent fusion of the vessel lumen. The system has been designed to produce minimal sticking, charring, or thermal spread to adjacent tissue.

Warning

Do not attempt to fuse lung tissue with LigaSure mode or instruments.

LigaSure Instruments

The LigaSure instruments that complete the ForceTriad tissue-fusion system include multiple reusable and single-use instruments for open and laparoscopic procedures. Each reusable instrument requires a corresponding single-use electrode. The LigaSure function is available only when using LigaSure instruments.

Chapter 2

Patient and Operating Room Safety

The safe and effective use of electrosurgery depends to a large degree upon factors solely under the control of the operator. There is no substitute for a properly trained and vigilant surgical team. It is important that the operating instructions supplied with this or any electrosurgical equipment be read, understood, and followed.

Electrosurgery has been used safely in millions of procedures. Before starting any surgical procedure, the surgeon should be trained in the particular technique and surgical procedure to be performed, should be familiar with the medical literature related to the procedure and potential complications, and should be familiar with the risks versus the benefits of utilizing electrosurgery in the procedure.

General

Setting Up the System

Warning

Electric Shock Hazard Connect the system power cord to a properly grounded power receptacle. Do not use power plug adapters.

Fire Hazard Do not use extension cords.

Patient Safety Use the system only if the power-up self-test has been completed as described in this manual, otherwise inaccurate power outputs may result.

Warning

Hazardous Electrical Output This equipment is for use only by trained, licensed physicians.

Do not use electrosurgical equipment unless properly trained to use it in the specific procedure being undertaken. Use of this equipment without such training can result in serious, unintended patient injury, including bowel perforation and unintended, irreversible tissue necrosis.

Always use the lowest power setting that achieves the desired surgical effect. The active electrode should be utilized only for the minimum time necessary in order to lessen the possibility of unintended burn injury. Accidental and unintended burn injury has occurred during procedures in small surgical fields and on small appendages. Pediatric applications and/or procedures performed on small anatomic structures may require reduced power settings. The higher the current flow and the longer the current is applied, the greater the possibility of unintended thermal damage to tissue, especially during use on small structures.

Do not wrap the instrument cords or patient return electrode cords around metal objects. This may induce currents that could lead to shocks, fires, or injury to the patient or surgical team.

Electric Shock Hazard Do not connect wet instruments to the energy platform. Ensure that all instruments and adapters are correctly connected and that no metal is exposed at any connection points.

Confirm proper power settings before proceeding with surgery. If the proper power settings are not known, set the power to a low setting and slowly increase the power until the desired effect is achieved. If increased power settings are requested, check the patient return electrode and all instrument connections before making major power setting adjustments.

Contact between the active electrode and any metal greatly increases current flow and can result in unintended surgical effect.

Warning

While using electrosurgery, the patient should not be allowed to come into direct contact with grounded metal objects (e.g., surgical table frame, instrument table, etc.). If this is not possible during certain procedures (e.g., those in which non-insulated head frames are used), use extreme caution to maximize patient safety:

- Use the lowest power setting that achieves the desired effect.
- Place the patient return electrode as close to the surgical site as possible.
- Place dry gauze between the patient and the grounded object if possible.
- Continually monitor the contact point(s).
- Do not use metal needle monitoring electrodes.

Caution

Read all warnings, cautions, and instructions provided with this system before using.

Read the instructions, warnings, and cautions provided with electrosurgical instruments before using. Specific instructions for electrosurgical instruments are not included in this manual.

For surgical procedures where the current could flow through delicate parts of the body, the use of bipolar techniques may be desirable in order to avoid unwanted coagulation.

Examine all instruments and connections to the system before using. Ensure that the instruments function as intended. Improper connection may result in arcs, sparks, instrument malfunction, or unintended surgical effects.

Do not turn the activation tone down to an inaudible level. The activation tone alerts the surgical team when the system is delivering RF energy.

When using a smoke evacuator in conjunction with the system, set the system volume control at a level that ensures that the activation tones can be heard.

Connect only Covidien-approved footswitches. Using footswitches from other manufacturers may cause equipment malfunction.

A non-functioning system may cause interruption of surgery. A backup system should be available for use.

Studies have shown that smoke generated during electrosurgical procedures can be potentially harmful to patients and the surgical team. These studies recommend adequately ventilating the smoke by using a surgical smoke evacuator or other means. [a]

Inadvertent activation may occur while installing, removing, or bending electrodes. Ensure that the instrument cord is not connected to the system or that the system is OFF.

a. U.S. Department of Health and Human Services. National Institute for Occupational Safety and Health (NIOSH). Control of Smoke from Laser/Electric Surgical Procedures. HAZARD CONTROLS, Publication No. 96-128, September, 1996.

Notice

Connect the power cord to a properly grounded power receptacle having the correct voltage; otherwise, product damage may result.

Important

If required by local codes, connect the system to the hospital equalization connector with an equipotential cable.

Fire/Explosion Hazard

Warning

Explosion Hazard Do not use electrosurgery in the presence of flammable anesthetics.

Fire Hazard Do not place active instruments near or in contact with flammable materials (such as gauze or surgical drapes). Electrosurgical instruments that are activated or hot from use can cause a fire. When not in use, place electrosurgical instruments in a safety holster or safely away from patients, the surgical team, and flammable materials.

Fire Hazard Sparking and heating associated with electrosurgery can be an ignition source. Keep gauze and sponges wet. Keep electrosurgical electrodes away from flammable materials and oxygen (O_2) enriched environments.

Use of electrosurgery in O_2 rich environments increases the risk of fire. Therefore, take measures to reduce the O_2 concentration at the surgical site.

Avoid enriched O_2 and nitrous oxide (N_2O) atmospheres near the surgical site. Both O_2 and N_2O support combustion and may result in fires and burns to patients or surgical personnel.

If possible, stop supplemental oxygen at least one minute before and during use of electrosurgery.

Do not activate the system until flammable vapors from skin prep solutions and tinctures have dissipated.

Avoid the accumulation of naturally occurring flammable gases that may accumulate in body cavities such as the bowel.

Prevent pooling of flammable fluids and the accumulation of flammable or oxidizing gases or vapors under surgical drapes or near the surgical site.

Tissue buildup (eschar) on the tip of an active electrode may create embers that pose a fire hazard, especially in oxygen enriched environments. Keep the electrode clean and free of all debris.

Facial and other body hair is flammable. Water soluble surgical lubricating jelly may be used to cover hair close to the surgical site to decrease flammability.

Verify that all anesthesia circuit connections are leak free before and during use of electrosurgery.

Warning

Fire Hazard During Oropharyngeal Surgery

Verify endotracheal tubes are leak free and that the cuff seals properly to prevent oxygen leaks.

If an uncuffed tube is in use, pack the throat with wet sponges around the uncuffed tube, and be sure to keep sponges wet throughout the procedure.

Question the need for 100% O_2 during oropharyngeal or head and neck surgery.

If necessary, scavenge excess O_2 with separate suction.

ForceTriad Energy Platform

Warning

Each instrument receptacle on this system is designed to accept only one instrument at a time. Follow the instructions provided with electrosurgical instruments for proper connection and use.

Caution

Do not stack equipment on top of the system or place the system on top of electrical equipment. This is an unstable configuration and does not allow for adequate cooling.

Provide as much distance as possible between the system and other electronic equipment (such as monitors). Do not cross or bundle electronic-device cords. This system may cause interference with other electronic equipment.

Active Instruments

Caution

Read the instructions, warnings, and cautions provided with electrosurgical instruments before using. Specific instructions for electrosurgical instruments are not included in this manual.

Inspect instruments and cords for breaks, cracks, nicks, and other damage before every use. If damaged, do not use. Damaged instruments or cords may result in injury or electrical shock to the patient or surgical team.

Use only instruments that can withstand the maximum output (peak) voltage for each output mode as listed in Chapter 4, *Technical Specifications*. Using an instrument with a voltage rating that is lower than the maximum output voltage may result in injury to the patient or the operator, or damage to the instrument.

All Covidien instruments have voltage ratings that are greater than the maximum output voltages in the system and are thus fully compatible.

Information on voltage ratings for non-Covidien instruments should be obtained from the instrument's manufacturer.

Implanted Electronic Devices (IEDs)

IEDs include, but are not limited to, pacemakers, neurostimulators, implantable cardioverter defibrillators (ICDs), ventricular assist devices (VAD), spinal cord stimulators, cochlear implants, infusion pumps and bone growth stimulators.

Warning

If the patient has an implanted electronic device (IED), contact the IED manufacturer for instructions before performing an electrosurgical or tissue-fusion procedure. Electrosurgery or tissue fusion may cause multiple activations of ICDs, or interfere with the intended function of other IEDs.

If the patient has an implanted electronic device (IED), contact the IED manufacturer for instructions before performing an electrosurgical or tissue-fusion procedure. Electrosurgery or tissue fusion may cause multiple activations of ICDs, or interfere with the intended function of other IEDs.

After Surgery

Warning

Electric Shock Hazard Always turn off and unplug the ForceTriad energy platform before cleaning.

Caution

Do not reprocess, reuse or resterilize instruments labeled “disposable” or “single use only.”

Notice

Do not clean the system with abrasive cleaning or disinfectant compounds, solvents, or other materials that could scratch the panels or damage the system.

Monopolar

Warning

Simultaneously activating suction/irrigation and electrosurgical current may result in increased arcing at the electrode tip, burns to unintended tissues, or shocks and burns to the surgical team.

Some surgeons may elect to "buzz the hemostat" during surgical procedures. It is not recommended, and the hazards of such a practice probably cannot be eliminated. Burns to the surgeon's hands are possible. To minimize the risk take these precautions:

- "Buzz the hemostat" below hand level (as close as possible to the patient) to reduce the opportunity for current to follow alternate paths through the surgeon's hands.
- Do not "buzz the hemostat" with a needle electrode.
- Do not lean on the patient, the table, or the retractors while buzzing the hemostat.
- Activate cut rather than coag. Cut has a lower voltage than coag.
- Firmly grasp as much of the hemostat as possible before activating the system. This disperses the current over a larger area and minimizes the current concentration at the finger tips.
- Use the lowest power setting possible for the minimum time necessary to achieve hemostasis.
- Activate the system after the instrument makes contact with the hemostat. Do not arc to the hemostat.
- When using a coated- or nonstick-blade electrode, place the edge of the electrode against the hemostat or other metal instrument.

Patient Return Electrodes

Warning

Do not attempt to use patient return electrodes that disable the REM system. The REM system functions correctly only with contact quality monitoring (CQM) split-style patient return electrodes. Any other patient return electrode products may cause patient injury or product damage.

The safe use of monopolar electrosurgery requires proper placement of the patient return electrode. To avoid electrosurgical burns beneath the patient return electrode, follow all directions provided with the product.

Do not cut a patient return electrode to reduce its size. Patient burns due to high current density may result.

A patient return electrode is not necessary in bipolar or LigaSure procedures.

To avoid patient burns, ensure that the patient return electrode firmly and completely contacts the skin. Always check the patient return electrode periodically and after the patient is repositioned and during procedures involving long periods of activation.

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) increases the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Notice

Capacitive pads and other non-CQM patient return electrodes may not work with the system.

Important

A statement of compatibility from the CQM patient return electrode manufacturer should be obtained prior to the use of a non-Covidien CQM patient return electrode.

Inadvertent Radio Frequency (RF) Burns

Warning

Electrodes and probes used with monitoring, stimulation, and imaging devices (or similar equipment) can provide a path for high-frequency current even if the electrodes or probes are isolated at 50 Hz to 60 Hz, insulated, and/or battery operated.

Do not use needles as monitoring electrodes during electrosurgical procedures. Inadvertent electrosurgical burns may result.

To reduce the risk of an inadvertent electrosurgical burn at the electrode or probe site, place the electrode and/or probe as far away as possible from the electrosurgical site and/or patient return electrode. Protective impedances (resistors or RF inductors) installed in the monitoring leads may reduce the risk of such burns. Consult the hospital biomedical engineer for further information.

In some circumstances, the potential exists for alternate site burns at points of skin contact (e.g., between the arm and the side of the body). This occurs when electrosurgical current seeks a path to the patient return electrode that includes the skin-to-skin contact point. Current passing through small skin-to-skin contact points is concentrated and may cause a burn. This is true for ground referenced and isolated output electrosurgical energy systems.

To reduce the potential for alternate site burns, do one or more of the following:

- Avoid skin-to-skin contact points, such as fingers touching leg or knee touching knee when positioning the patient.
- Place insulation, such as dry gauze or towel, between contact points to ensure that contact does not occur.
- Position the patient return electrode to provide a direct current route between the surgical site and the return electrode which avoids skin-to-skin contact areas.
- In addition, place patient return electrodes according to the manufacturer's instructions.

Laparoscopic Procedures

Warning

For laparoscopic procedures, be alert to these potential hazards:

- Laparoscopic surgery may result in gas embolism due to insufflation of gas in the abdomen.
- The electrode tip may remain hot enough to cause burns after the electrosurgical current is deactivated.
- Inadvertent activation or movement of the activated electrode outside of the field of vision may result in injury to the patient.
- Localized burns to the patient or physician may result from electrical currents carried through conductive objects (such as cannulas or scopes). Electrical current may be generated in conductive objects through direct contact with the active electrode, or by the active instrument (electrode or cable) being in close proximity to the conductive object.
- Do not use hybrid trocars that have a non-conductive locking anchor placed over a conductive sleeve. For the operative channel, use all-metal or all-plastic systems. At no time should electrical energy pass through hybrid systems. Capacitive coupling of RF current may cause unintended burns.
- When using laparoscopic instrumentation with metal cannulas, the potential exists for abdominal-wall burns to occur due to direct electrode contact or capacitive coupling of RF current. This is most likely to occur in instances where the system is activated for extended periods at high power levels inducing high current levels in the cannula.
- Ensure that the insulation of single-use and reusable laparoscopic instrumentation is intact and uncompromised. Compromised insulation may lead to inadvertent metal-to-metal sparking and neuromuscular stimulation and/or inadvertent sparking to adjacent tissue.
- Do not activate electrodes while in contact with other instruments as unintended tissue injury may occur.

Do not activate the system in an open-circuit condition. To reduce the chances of unintended burns, activate the system only when the active electrode is near or touching the target tissue.

- Use the lowest power setting that achieves the desired surgical effect and use a low-voltage waveform (Pure Cut, Blend, or Valleylab mode) to lessen the potential for the creation of capacitive currents.
- Carefully insert and withdraw active electrodes from cannulas to avoid possible injury to the patient or damage to the devices.

Covidien recommends against the use of laparoscopic surgery on pregnant patients.

Bipolar

Caution

Bipolar instruments must be connected to the bipolar instrument receptacle only. Improper connection may result in inadvertent system activation.

LigaSure

Warning

LigaSure instruments are intended for use ONLY with the ForceTriad energy platform and the LigaSure vessel sealing system. Use of these instruments with other Covidien generators or with generators produced by other manufacturers may not result in electrical output for which these instruments were designed and thus may not result in the desired clinical effect.

If the seal-complete tone has not sounded, an optimal seal may not have been achieved. Reactivate the RF energy until a seal-complete tone is heard.

The LigaSure tissue-fusion function has not been shown to be effective for tubal sterilization or tubal coagulation for sterilization procedures. Do not use this function for these procedures.

Use caution during surgical cases in which patients exhibit certain types of vascular pathology (atherosclerosis, aneurysmal vessels, etc.). For best results, apply the seal to unaffected vasculature.

Do not activate the system in the LigaSure mode until the tissue-fusion instrument has been applied with the proper pressure. Activating the system before this is done results in an improper seal and may increase thermal spread to tissue outside the surgical site.

Tissue fusion requires the application of RF energy and pressure from the instrument. Tissue to be sealed must be firmly grasped between the instrument jaw electrodes. Tissue in the jaw hinge or outside the instrument jaw will not be sealed even if thermal blanching occurs.

Do not use LigaSure instruments on vessels in excess of 7 mm in diameter.

LigaSure instruments that require single-use electrodes must be used with the correct electrode type. Use of these instruments with any other electrodes could result in injury to the patient or surgical team, or cause damage to the instrument.

Conductive fluids (e.g, blood or saline) in direct contact with LigaSure instruments or in close proximity may carry electrical current or heat, which may cause unintended surgical effects or burns.

Caution

Energy based devices, such as electrosurgical pencils or ultrasonic scalpels, that are associated with thermal spread should not be used to transect seals.

Avoid placing fingers in the handle ratchet mechanism or between the ring handles or jaws as applicable depending on the type of instrument. Injury to the user may result.

LigaSure in Laparoscopic Procedures

Warning

For laparoscopic procedures, be alert to these potential hazards:

- The external surfaces of the LigaSure instrument jaws may remain hot enough to cause burns after the RF current is deactivated.
- Inadvertent activation or movement of the activated LigaSure instrument outside of the field of vision may result in injury to the patient.
- Do not activate the instrument while the instrument jaws are in contact with, or in close proximity to, other instruments including metal cannulas, as localized burns to the patient or physician may occur.
- Do not activate the LigaSure function in an open circuit condition. Activate the system only when the instrument is near or in direct contact with the target tissue to reduce the possibility of unintended burns.
- Carefully insert and withdraw LigaSure instruments from cannulas to avoid possible damage to the devices and/or injury to the patient.

Servicing

Warning

Electric Shock Hazard Do not remove the system cover. Contact qualified personnel for service.

Notice

Refer to Chapter 9, *Maintenance and Repair* for maintenance recommendations and function and output power verification procedures.

Shunt Cords

Warning

Some surgical instruments (e.g., colonoscopes) may allow substantial leakage current that could burn the surgeon. If the instrument manufacturer recommends the use of a shunt cord (s-cord) to direct the current back to the system, you must also use a E0507-B adapter. To avoid a REM alarm, you must use a REM Polyhesive™ patient return electrode with the E0507-B adapter.

Conductive Fluid in the Surgical Site

Warning

When this system is used in procedures where conductive fluid (saline or lactated Ringers) is introduced into the surgical site for distention or to conduct RF current, higher than normal currents (greater than one amp) may be produced. In this situation, use one or more adult-size return electrodes. Do not use return electrodes labeled for children, infants, babies, neonatal use, or pediatric use.

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) increases the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Chapter 3

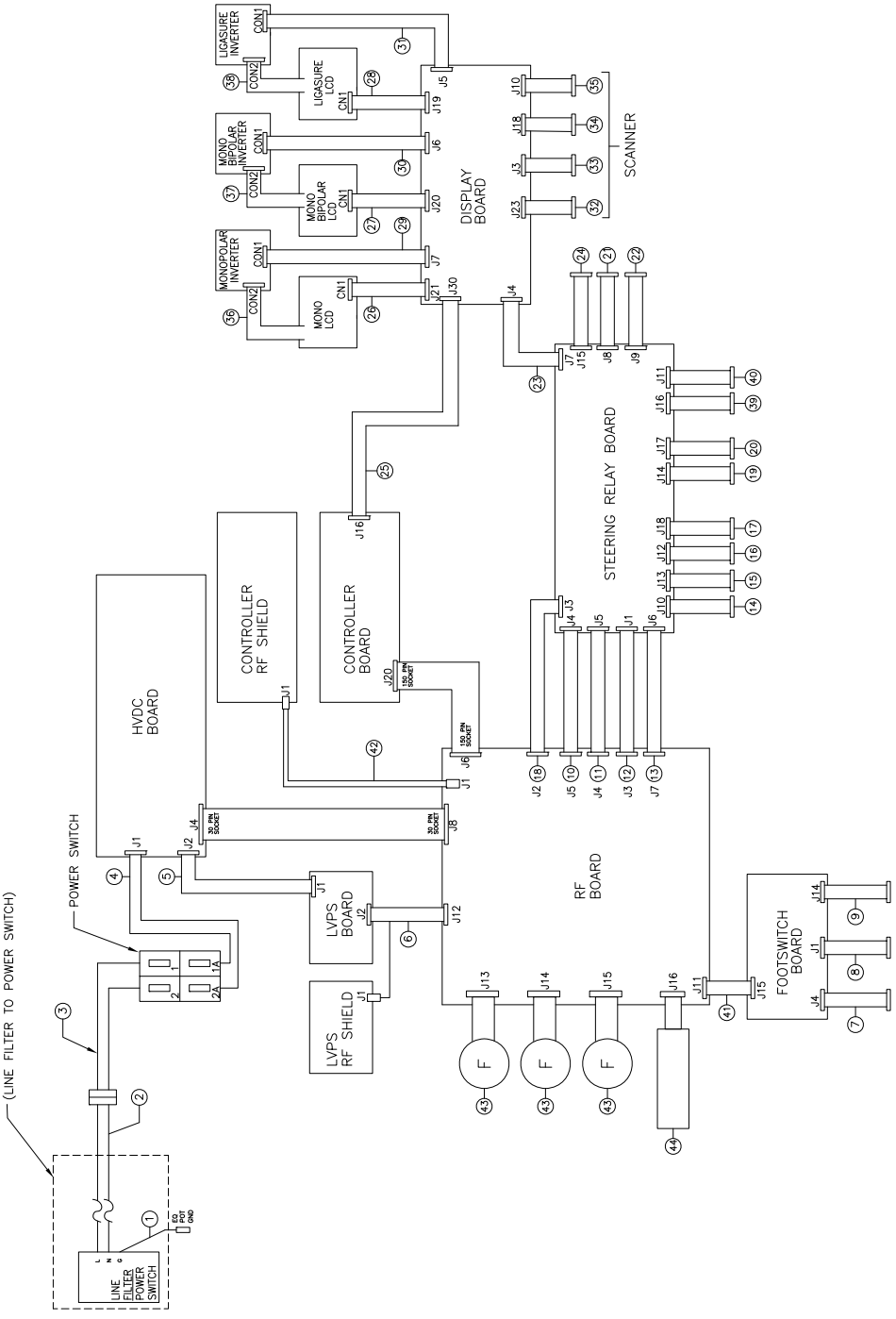
Principles of Operation

This chapter provides detailed information about how the ForceTriad energy platform functions and how the internal components interact.

This chapter includes the following information:

- A block diagram that illustrates how the system functions
- A general description of how the system works
- Detailed descriptions of the circuitry for the printed PCBAs

Block Diagram



Block Diagram key to numbers

1 ASSY CABLE CHASSIS-GND NHP	23 CABLE DISPLAY POWER FORCETRIAD
2 CABLE AC FILTER-SWITCH FORCETRIAD	24 CABLE UFAP SENSE FORCETRIAD
3 CABLE PANEL-SWITCH FORCETRIAD	25 CABLE ETHERNET 27 INCH
4 CABLE AC SWITCH HVDC FORCETRIAD	26 CABLE FLEX LCD-DISPLAY FORCETRIAD
5 CABLE HVDC-LVPS FORCETRIAD	27 CABLE FLEX LCD-DISPLAY FORCETRIAD
6 CABLE RF-LVPS FORCETRIAD	28 CABLE FLEX LCD-DISPLAY FORCETRIAD
7 CABLE SPEAKER FORCETRIAD	29 CABLE LCD-INVERTER FORCETRIAD
8 CABLE LIGASURE 1 FTSW FORCETRIAD	30 CABLE LCD-INVERTER FORCETRIAD
9 CABLE LIGASURE 2 FTSW FORCETRIAD	31 CABLE LCD-INVERTER FORCETRIAD
10 CABLE REM SR-RF FORCETRIAD	32 CABLE RIBBON SCANNER FORCETRIAD (LIG 1)
11 CABLE MONO OUT FORCETRIAD	33 CABLE RIBBON SCANNER FORCETRIAD (LIG 2)
12 CABLE RF-STEERING FORCETRIAD	34 CABLE RIBBON SCANNER FORCETRIAD (MONO 1)
13 CABLE AUTOBIPOLAR FORCETRIAD	35 CABLE RIBBON SCANNER FORCETRIAD (LIG 2)
14 CABLE LIG 1 OUTPUT FORCETRIAD	36 INTEGRAL TO LCD ASSEMBLY
15 CABLE LIG 2 OUTPUT FORCETRIAD	37 INTEGRAL TO LCD ASSEMBLY
16 CABLE BIP OUTPUT FORCETRIAD	38 INTEGRAL TO LCD ASSEMBLY
17 CABLE BIPOLAR SENSE FORCETRIAD	39 CABLE UFP POWER FORCETRAID
18 CABLE ACTIVE BIPOLAR SENSE	40 ASSY CABLE REM RETURN FORCETRIAD
19 CABLE MONO 1 OUTPUT	41 CABLE RF-FOOTSWITCH FORCETRIAD
20 CABLE MONO 2 OUTPUT	42 CABLE RF SHIELD FORCETRIAD
21 CABLE DISPLAY POWER	43 not orderable
22 CABLE MONO MODE FORCETRIAD	44 JUMPER CABLE FAN FEP

Functional Overview

The ForceTriad energy platform is a combination of a full-featured general-surgery electrosurgical unit and a LigaSure vessel sealing system. The monopolar and bipolar sections of the system are isolated electrosurgical outputs that provide the appropriate power for cutting, desiccating, and fulgurating tissue during monopolar and bipolar surgery. The LigaSure section of the system provides power for vessel sealing.

During monopolar electrosurgery, radio frequency (RF) current flows from the system to an active electrode, which delivers the current to the patient. The resistance to the current, provided by the patient's tissue and/or the air between the active electrode and the tissue, produces the heat that is necessary for the surgical effect. The RF current flows from the active electrode, through the patient's body tissue to the return electrode, which recovers the current and returns it to the system.

The LigaSure vessel sealing system provides precise energy delivery and electrode pressure to vessels for a controlled time period to achieve a complete and permanent fusion of the vessel lumen.

TissueFect Tissue Sensing Technology

The system automatically senses resistance and adjusts the output voltage to maintain a consistent tissue effect across different tissue impedance. This adjustment is based on the selected mode, the power setting, and the level of tissue resistance.

REM Contact Quality Monitoring System

The system uses the REM Contact Quality Monitoring system to monitor the quality of electrical contact between the patient return electrode and the patient. The REM system is designed to minimize the risk of burns at the return electrode site during monopolar electrosurgery.

When the user connects a REM Polyhesive patient return electrode to the patient return electrode receptacle, they activate the REM system. When the user activates monopolar output, the system connects the patient return electrode path. If the user activates bipolar output while a return electrode is connected to the patient, the return electrode circuit is deactivated automatically to eliminate the possibility of current dispersal.

The REM system continuously measures resistance at the return electrode site and compares it to a standard range of safe resistance (between 5 Ω and 135 Ω), thus minimizing intermittent false alarms that could result from small changes in resistance.

The REM system also adapts to individual patients by measuring the initial contact resistance (baseline resistance) between the patient and the patient return electrode. If the tissue impedance at the return electrode decreases during electrosurgery, the REM system resets the baseline resistance.

REM Alarm Activation

The REM Alarm indicator flashes red, a tone sounds, and the system stops producing output power when either of the following occurs:

- The measured resistance is below 5 Ω or above 135 Ω, the limits of the standard range of safe resistance.
- An increase in contact resistance is greater than 40% from the initial measurement (baseline resistance).

The REM Alarm indicator remains illuminated red until the condition causing the alarm is corrected. Then, the indicator illuminates green and RF output is enabled.

Electrodes Without the REM Safety Feature

Return electrodes without the REM safety feature cannot be used on the system.

High-Voltage DC (HVDC PCBA) Power Supply Principles of Operation

The HVDC power supply regulates an output DC voltage to a desired level that is proportional to a 0 V to 5 V analog logic signal called Voltage Control (ECON). The AC input range is 85 VAC to 264 VAC with line frequencies from 47 Hz to 63 Hz. The HVDC can be simplified into two sections, the AC section and DC section.

The AC section rectifies the AC input into the rectified +Bus and –Bus voltages. For line voltages of 150 VAC or less, the rectified AC voltage is doubled. The rectified voltage is monitored and is flagged if the voltage starts to drop too low or if the rectified voltage exceeds 400 VDC. As a safety feature, the HVDC shuts down when it exceeds 400 VDC. The AC section also incorporates a soft start circuit that reduces the inrush AC current at power up.

The DC section is a phase-shifted full-bridge topology and uses a Pulse Width Modulator (PWM). The DC section consists of limits that help protect the HVDC from fault conditions.

These limits include over voltage, over current, over power, and short circuit. Each limit sends a flag to the controller PCBA if it is triggered and shuts down the HVDC. Another feature of the HVDC is an active discharge circuit; this circuit places a load across the output. This allows the output of the HVDC to discharge quickly no matter what the load attached to the HVDC.

RF PCBA Principles of Operation

The primary purpose of the ForceTriad RF PCBA is to convert the DC voltage coming from the HVDC PCBA into a 470 kHz RF signal that is sent to the Steering Relay PCBA to be distributed to the appropriate output.

A push-pull topology is used to accomplish this voltage conversion. Two gate-drive signals that are 180° out of phase are used to drive the high-voltage Field Effect Transistors (FETs), called T ON and T ON 180. The gate-drive signals turn on each of the FETs at opposite times to deliver a waveform at the specified power requested from the user.

The RF PCBA is capable of several different outputs ranging from 5.5 A RMS in LigaSure tissue fusion modes to over 7 KVpp in coag modes. Relays throughout the RF PCBA switch in the appropriate tuning elements required to achieve these various outputs.

Primary and redundant sense circuits detect the RF output voltage and current. An accurate scaled down AC voltage representative of each of these is sent to the controller PCBA, which in turn keeps the output at levels appropriate for the mode in use.

Four sense relays for each circuit correspond to specific modes and switch in voltage dividers tuned to divide the output signals to levels that are manageable for the controller PCBA.

Three relays for each voltage sense circuit divide down the output voltages from 425 Vpk - 5000 Vpk to around 1 Vpk, depending on the mode selected by the user. The current sensors use one relay for each circuit; this relay activates for currents higher than 1 A RMS. The sensor signals are passed through a multiplier which uses a gain control signal from the controller PCBA.

After this multiplier stage, the signal is filtered and routed to the controller PCBA. RF voltage and current foldback circuits use the ranges selected on the sensors to determine if a limit has been reached. These circuits fold back the ECON signal going to the HVDC, reducing the DC output to the RF PCBA. This in turn reduces the RF output amplitude.

REM

The Return Electrode Monitor (REM) circuit monitors the resistance between the two return areas on a REM electrode using an 80 kHz signal generated by the controller PCBA.

Autobipolar

The Autobipolar (ABP) circuit consists of an 80 kHz signal, also generated by the controller PCBA. It is used to monitor the bipolar output impedance.

Leakage Current Monitor

The RF PCBA also features a leakage current monitor circuit, which measures the active and return of the system and puts out a DC voltage that represents the difference

between the two. If this voltage exceeds a limit, the RF is folded back to prevent excess leakage current.

Sensor Circuit

The sensor circuit provides RF output voltage and current monitoring to software in order to deliver the correct energy dosage during a surgical procedure. Two identical sensory circuit paths, composed of a primary and backup, are implemented to provide fail-safe mitigation in the event of circuit failure.

Because each primary and backup sensor circuit mirrors the other, the sensed output voltages, which are monitored by software, are equal when the sensory system maintains proper operation. In the event of a failure of the primary or backup sense circuit, dissimilar outputs are present and software detection stops delivery of RF. The user is notified with an error message displayed on the front panel of the ForceTriad energy platform.

Each primary and backup sensory circuit consists of four processing elements to ensure that the correct RF is delivered. In the description that follows, the primary sensory path is identified for the voltage-sense circuitry, with reference designation only provided to the backup circuit.

Backup-circuit operation is identical to the primary circuit that is described here. RF current-sense circuit process is symmetrical to the voltage-sense description in that it also uses four processing elements. The only notable difference between voltage and current sensing is the different transfer gains required to adequately address the dynamic range of individual system operating modes.

First: Transformer T6, along with resistors R110 and R119, provide RF output voltage monitoring by generating a proportionately scaled, secondary-sense voltage, which is correlated to the delivered RF output voltage. Backup referenced components are T1, R95, and R111.

Second: Coupled to the secondary of transformer T6, a software-controlled switched-pad network is implemented to provide proper impedance scaling to address the dynamic sensory range required for all operating modes of the system.

This pad-impedance switched network is used to develop the proportionately scaled secondary sense voltage of T6. Resistors R103 and R107 provide the initial impedance termination, paralleled by resistor-paired components R104 and R105, R94 and R106, and R85 and R100, which are switched independent on the selected system cut, blend, and coag operating modes respectively.

Paired-resistor switching is accomplished by electronic-switch components RL12, RL11, and RL10 respectively. Backup referenced-terminating components are R89 and R93; paired components are R90 and R91, R88 and R92, and R81 and R84; and switch components are RL9, RL8, and RL7, which are used respectively.

Third: The Pad network output of T6 is then differentially fed to a gain control module, U18, which provides continuous gain control to normalize the sensed voltage output, independent of system operating modes and delivered RF power levels.

Amplifier, U19, buffers the signal received from software which is used to precisely control the gain of U18, while amplifier U17 provides a scaled differential-output voltage,

a result of U18 gain processing. Backup referenced components are gain-control module U40, buffer amp U31, and difference amp U30 respectively.

Fourth: The output of amplifier U17 is now delivered to the last stage for sensory-signal processing. An anti-alias filter device, U16, receives the difference signal from U17. The last stage of sensor processing provides a benefit to the RF-monitored output; it increases the accuracy of the delivered RF by minimizing noise to the sensed signals. Backup components U29, R190, and R216 are used.

Steering Relay PCBA Principles of Operation

To accommodate the need for high isolation between the patient and ground-referenced voltages during use, the ForceTriad Steering Relay PCBA design incorporates several different types of relays designed for very high voltage standoff. In addition, cut-outs on the PCBA increase distances at strategic locations to help reduce creepage issues.

Multiple functions are performed by the Steering Relay PCBA. The main function is to route the 470 kHz from the RF PCBA to one of the six outputs. The outputs are as follows: LigaSure 1, LigaSure 2, Bipolar, Mono 1, Mono 2, and Footswitch Controlled outputs

Because only one output can be active at any given time, the Steering Relay PCBA plays an important role in maintaining the isolation between all the outputs and their respective circuits. During mono and footswitch modes, a return path, called Mono return, is required.

Mono return is monitored with a Return Electrode Monitor (REM) circuit. This circuit monitors the resistance between the two return areas on a REM electrode. The actual REM circuit is on the RF PCBA, but this 80 kHz signal is routed through the Steering Relay PCBA to the Mono return.

Another signal that is routed from the RF PCBA to the Steering Relay PCBA is the Autobipolar (ABP) signal. This 80 kHz signal monitors the bipolar output impedance.

Another important function of the Steering Relay PCBA is hand-switching detection. The circuits used to detect hand-switching requests are powered from individual, highly isolated power supplies.

These power supplies use transformers that convert ground referenced +12 V to an isolated +8 V or +5 V, each referenced to its corresponding output. Five handswitching power supplies are available: LigaSure 1, LigaSure 2, Bipolar, Mono 1, and Mono 2. When an active hand-switch signal is detected, the detection signal is transferred across an optocoupler and is sent to the microprocessor.

The final function of this PCBA is footswitch and bipolar sense. These circuits determine if an instrument is connected to any of the receptacles.

Circuit Descriptions for the ForceTriad Display PCBA

Hotlink Transceiver U1

The Cypress Hotlink II transceiver U1 handles all communications between the Display PCBAs Field Programmable Gate Array (FPGA) U28 and the controller PCBA. A single IC handles bi-directional communication.

Liquid Crystal Display (LCD) Driver Inside the FPGA U28

The LCD driver receives video data from the controller PCBA and outputs it to the displays. Data is written into a 16-pixel deep First In/First Out (FIFO) when received from the serial link. Data is read out of the FIFO and presented to the displays at the pixel rate.

For the ForceTriad energy platform, this yields a display refresh rate of ~46 Hz. In either case, the pixel rate must be derived from the receive clock to keep the display output in sync with the display data generation on the controller PCBA and prevent overflowing or under flowing of the pixel FIFO.

Touchscreen Driver

The touch-screen driver reads user input from the touchscreens. Three touchscreens are attached to the Display PCBA, each through its own five-wire interface. The touchscreen driver polls each screen in turn to determine whether the user is pressing on it. If so, the X and Y position of the touch are detected.

On the ForceTriad Display PCBA, load switching FETs are used to drive voltages onto the four electrical-drive connections, and the voltage on the sense connection is read by an Analog Digital Converter (ADC) U4. The drive circuitry normally drives +3.3 V to all four drive connections, while the sense connection is pulled weakly to ground.

To measure an X coordinate, the FPGA applies 3.3 V to the upper-right and lower-right corners of the touch screen, and ground to the upper-left and lower-left corners. The ADC reads the voltage on the sense line and sends it to the FPGA as a digital value. The FPGA stores this value in the touch-screen register. The FPGA then measures a Y coordinate by applying 3.3 V to the upper-right and lower-right corners, and ground to the lower-left and lower-right corners. The ADC reads the voltage on the sense line and sends it to the FPGA as a digital value. The FPGA stores this value in the touch-screen register along with the X-coordinate value and the address of the touchscreen that has been touched. The register data is sent to the Controller which updates the display image.

Barcode Driver

The Display PCBA supports communication with four barcode readers through a quad-Universal Asynchronous Receiver/Transmitter (UART) U14. One channel of the serial-interface side of the UART is connected to each barcode reader, while the control side is connected to the display FPGA.

The barcode driver reads data bytes out of the UART as they are received from the barcode readers and sends them to the controller PCBA. It also writes data and control bytes to the UART as specified by the controller PCBA.

Power Supply

The power supply is dual DC to DC converter U16. The power supply has an input of 5 V and converts it down to 3.3 V and 1.8 V outputs.

Footswitch/Audio PCBA Circuitry Description

Overview

The primary function of the audio circuitry is to receive commands from the Interface Control Logic (ICL) FPGA on the controller PCBA through a serial, two-wire SMBus data link. The FPGA on this PCBA processes that data to determine three parameters; wave file, volume, and duration.

Based on these parameters, the FPGA accesses corresponding parallel data from flash memory, serializes it and passes it out to the DAC. Control data is also passed to the DAC that sets the volume level of the output-amplifier stage. Footswitch data is collected and sent to the controller PCBA as well.

Finally, the expansion port has an RS-232 and ECG/blanking relay interface that connects directly to the controller PCBA and DAC controlled by this FPGA.

Power Supplies

This PCBA requires 2 power supplies: 5 V and 12 V. From those input voltages it also generates 2.5 V, 3.3 V, and isolated supplies of +12 V, -12 V and +5 V. 5 V and 12 V are delivered to this PCBA through the RF PCBA connector.

The 2.5 V and 3.3 V supplies are regulated down from the 5 V supply on this PCBA. The 5 V rail should draw approximately 100 mA. The 12 V rail should draw approximately 500 mA at full volume with no expansion port peripherals connected.

The 12 V supply is used by the audio amplifier, TPA1517, and also generates all of the isolated-power supplies. The isolated-power supply can source approximately 250 mA on each, +12 V ISO and -12 V ISO, and 500 mA on +5 V ISO.

Communications

All communications between the controller PCBA and the Footswitch/Audio PCBA are conducted over a two-wire System Management Bus (SMBus). The master of this bus is the controller PCBA.

Audio Data

Three commands can be received from the controller PCBA; reset, parameter write and parameter read. The reset command resets all internal-state machines inside the FPGA. It also immediately stops a running audio stream. The parameter commands allow the controller to write and read three internal parameters that control sending out audio data.

These parameters are: wave file, duration, and volume.

The wave-file parameter selects a particular wave file in the flash memory by selecting a base memory address from a look up table.

The duration parameter selects how many times to repeat the wave file. Since each wave file is a fixed length, that file can be repeated up to 30 times, or it can be told to be sent out continuously until another command is received.

Finally, the volume parameter simply selects a volume level between 0 (mute) and 1024 (highest volume, approximately 60 dBA).

When a command is received, the FPGA processes that command only once. For example, if a particular wave file is selected to be played twice, the FPGA plays that wave file twice and then stop until a new command is received. If a wave file is to be played continuously, it can be set using the duration parameter.

Footswitch Data

Footswitch data is polled in this FPGA and, when a footswitch register read is received from the ICL FPGA, the footswitch-register data is sent to the ICL FPGA and then cleared. After being cleared, the FPGA immediately polls the footswitches for new footswitch activations. If an activation is detected, the FPGA holds a corresponding bit in the footswitch register until it is read by the ICL FPGA, even if the footswitch is depressed before that event occurs.

Expansion Port DAC Data

The ICL FPGA sends DAC data to this FPGA, which is then serialized and sent out to the expansion port DACs. Four DAC registers can be written to in this FPGA; each corresponds to a RF statistic: power, current, voltage, and load impedance.

DAC Amplifier

The DAC is an Analog Device AD1854. It is controlled by two serial interfaces. One interface streams left- and right-channel audio data. The other interface sends control data to the DAC, including amplification settings. The volume parameter is passed directly to the DAC by way of this interface.

The amplifier is an Analog Device TPA1517. It is a 6 W amplifier and runs off 12 V. For both the DAC and the amplifier, only one of the two channels is used since the Footswitch/Audio PCBA only has one speaker.

Isolated Footswitch and Expansion Port Circuitry

The footswitch circuit provides an isolated footswitch-detection circuit that passes footswitch data directly to this PCBA's FPGA. The FPGA, as noted above, polls the footswitches for activations.

The expansion port has an ECG/blanking relay that is directly controlled by the controller PCBA. The expansion port also has an RS-232 interface that links directly to the controller. And finally, it has a DAC that outputs analog data that corresponds to RF parameters.

Controller PCBA Principles of Operation

The controller PCBA regulates all system outputs, receives and interrupts all customer inputs, monitors the entire system for safety issues and proper functionality, and acts as the overall manager for all systems within the ForceTriad. The controller PCBA contains the host processor, Digital Signal Processors (DSP's), Interface Control Logic PLD (ICL), data converters, and external peripherals. These are discussed in the next few pages.

The controller PCBA constantly monitors the health and overall operation of the system. If the unit operates outside of a set of operational specifications built into the system, the system alerts the user of the malfunction or system issue using an error code. These error

codes are unique to the system issue. Each error code identifies the section or general area of concern within the system. Chapter 7, *Troubleshooting*, describes the error codes and components affected by the error.

The controller PCBA also acts as the interface with the user. The controller PCBA contains multiple communication ports. The ports are:

- RS-232 (primary communication path)
- USB port (may be disabled depending on system configuration)
- Ethernet port (may be disabled depending on system configuration)

Each port offers a two-way communication path between the user and the system. These ports give the user the ability to get stored data from the controller PCBA, upload the latest software revision, and allows the user to connect external testing equipment to the system for calibration, functional test, and preventive maintenance.

Host Processor

The host has FLASH, SDRAM, and SRAM memory blocks. All memory devices are directly connected to the address and data bus. The SRAM is a battery-backed device that also supports the system's real-time clock function. The host processor is also capable of external communication through two RS232 ports, an Ethernet port, and a USB port.

Digital Signal Processor (DSP) Controlled Data Converters

DSP1

The DSP is the main control-system processor. Its primary responsibility is control of the HVDC PCBA setting (by way of an on-board DAC), as well as the keying signal for the RF FETs (T_ON, T_ON_180).

It also reads a set of voltage and current sensors that complete the feedback loop of the control system. DSP1 has FLASH and SDRAM memories directly connected to its address and data bus.

DSP2

The second DSP in the system is the dosage-error processor. It reads a redundant set of the same sensors that DSP1 reads. Through a direct-connect serial channel (or through the ICL), the two DSPs are able to compare sensor results. DSP2 has FLASH and SDRAM memories directly connected to its address and data bus.

Interface Control Logic PLD

The purpose of the ICL is to act as Hardware Abstraction Layer (HAL) for the processors. Those peripherals not directly connected to the processors are connected to the ICL. The ICL also provides a communication channel for the three processors through a tri-port RAM. The peripherals connected to the ICL are:

- Footswitch/Audio PCBA
- PCBA ID bus
- Display PCBA (LCDs, barcode readers, and touchscreens)
- Low-Voltage Power Supply (LVPS) power-fail circuit
- REM and HVPS sensor circuits
- RF relays

Data Converters

There are four high-speed Analog-to-Digital Converters (ADCs) on the PCBA for voltage and current sensor data. There is also one slow-speed ADC for reading REM voltage as well as the HVPS output. There are three Digital-to-Analog Converters (DACs) on the PCBA as well.

One DAC is not used. The other two DACs are used by the DSPs to drive the gain of their respective voltage and current sensors. The DSP1 DAC also drives the voltage level of the HVPS.

External Peripherals

The controller PCBA has ports for talking to external peripherals through the following protocols: RS232, USB 1.1, and Ethernet.

Chapter 4

Technical Specifications

All specifications are nominal and subject to change without notice. A specification referred to as "typical" is within ± 20% of a stated value at room temperature (77° F/25° C) and a nominal line input voltage.

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Performance Characteristics

General

Output configuration	Isolated output
Cooling	Natural and forced convection, and fan
Display	Three LCD touchscreens
Connector ports	LED illuminated Smart-connector readers
Mounting	• ForceTriad energy platform cart (FT900), Universal Mounting cart (UC8009), and/or the UC8010 Overshelf • Operating-room boom systems • Any stable, flat surface such as a table or cart top

Dimensions and Weight

Width	18 in. (45.7 cm)
Depth	20 in. (50.8 cm)
Height	10 in. (25.4 cm)
Weight	30 lb. (13.6 kg)

Operating Parameters

Ambient temperature range	50° F to 104° F (+10° C to +40° C)
Relative humidity	30% to 75% non-condensing
Atmospheric pressure	700 millibars to 1060 millibars
Warm-up time	If transported or stored at temperatures outside the operating temperature range, allow one hour for the system to reach room temperature before use.

Transport and Storage

Ambient-temperature range	-22° F to 149° F (-30° C to +65° C)
Relative humidity	25% to 85% (non-condensing)
Atmospheric pressure	500 millibars to 1060 millibars
Duration of storage	The ForceTriad energy platform may be stored indefinitely. If the system is stored for over one year, the memory battery must be replaced, and the system must be re-calibrated in accordance with Chapter 9, *Maintenance and Repair*.

Internal Memory

Nonvolatile, battery-backed RAM	Battery type: Lithium Battery life: 120 mAh
Storage capacity	256 KB

Activation Tone

The audio levels stated below are for activation tones (cut, Valleylab, coag, bipolar, and LigaSure modes) and alarm tones (REM and system alarms) at a distance of one meter.

Volume (adjustable)	45 dBA to 65 dBA
Frequency	Cut – 660 Hz Valleylab – 800 Hz Coag – 940 Hz Bipolar – 940 Hz LigaSure – 440 Hz
Duration	Continuous while the system is activated

Alarm Tone

Volume (not adjustable)	> 65 dBA
Frequency	REM –660 Hz Reactivate/Regrasp, Check Instrument – Two tones High = 985 Hz, Low = 780 Hz Seal Complete – 985 Hz Error/System Alert – Beep tone = 1421 Hz
Duration	REM – Two 1/ 2 second tones separated by 1/2 second for each REM event Reactivate/Regrasp – Four 175 ms tones High, low, high, low Check Instrument – Six 175 ms tones High, low, high, low, high, low Seal Complete – Two 175 ms tones separated by 175 ms for each seal-complete event Error/System Alert – Three 250 ms tones separated by 250 ms for each error/system-alert event

REM Contact Quality Monitor

Interrogation frequency	80 kHz ± 10 kHz
Interrogation current	< 100 µA
Interrogation voltage	< 12 V RMS

Acceptable Resistance Range

REM resistance measurements are ± 10% during RF activation and ± 5% when RF output is not activated.

REM Polyhesive patient return electrode: 5 Ω το 135 Ω or up to a 40% increase in the initial measured contact resistance (whichever is less).

If the measured resistance is outside the acceptable range(s) noted above, a REM fault condition occurs.

REM Alarm Activation

REM Polyhesive patient return electrode: When the measured resistance exceeds the standard range of safe resistance (below 5 Ω or above 135 Ω) or when the initial measured contact resistance increases by 40% (whichever is less), the REM alarm indicator enlarges and flashes red and yellow, a tone sounds twice, and RF output is disabled. The indicator remains illuminated red and yellow until the user corrects the condition causing the alarm. Then, the indicator illuminates green and RF output is enabled.

Autobipolar

The system is equipped with an autobipolar feature that allows for automatic activation of bipolar energy.

Note: The autobipolar electrode function requires the use of a Reusable Footswitching Bipolar Cord E0020V, E0021S, E0022W, E360150, or E360150L.

Warning

Use of different Covidien cord models or cords from other manufacturers may not achieve proper electrical output for this device, thereby failing to produce the desired clinical effect. For example, Autobipolar activation/deactivation settings may not work properly using cords other than those specified by Covidien.

The autobipolar specifications are:

Interrogation frequency	80 kHz ± 10 kHz
Interrogation current	< 100 µA
Interrogation voltage	< 12V RMS
Activation impedance	20 Ω to 1000 Ω
Deactivation impedance	User selectable: 1,500 Ω, 1,800 Ω, 2,000 Ω or 2,200 Ω
Keying delay	User selectable in 500 ms increments from 0 sec to 2.5 sec.

Measurement Accuracy

Inactive		
± 5% of Full-scale activation impedance while keying inactive		
Active		
Mode: BP Low		
Load/Power	< 30 W	≥ 30 W
1 Ω – 500 Ω	± 20% or ± 25 Ω (Whichever is greater)	± 20% or ± 25 Ω (Whichever is greater)
501 Ω – 1000 Ω	± 40%	± 20%
1001 Ω – 2500 Ω	+100%/-50%	± 20%
> 2500 Ω	Reads > 2200 Ω	Reads > 2200 Ω
Mode: BP Standard		
Load/Power	< 50 W	≥ 50 W
1 Ω – 500 Ω	± 20% or ± 25 Ω (Whichever is greater)	± 20% or ± 25 Ω (Whichever is greater)
501 Ω – 1000 Ω	± 40%	± 20%

1001 Ω – 2500 Ω	+100%/-50%	± 20%
> 2500 Ω	Reads > 2200 Ω	Reads > 2200 Ω
Mode: BP Macro		
Load/Power	All power levels	
1 Ω – 2500 Ω	± 20% or ± 25 Ω (Whichever is greater)	
> 2500 Ω	Reads > 2200 Ω	

Duty Cycle

Under maximum power settings and rated load conditions, the system is capable of operating a duty cycle of 25%, defined as 10 seconds active and 30 seconds inactive, in any mode for a period of 4 hours.

Caution

Use of duty cycles greater than 25% (10 seconds active followed by 30 seconds inactive) increases the risk that heat build-up under a return electrode may be high enough to injure the patient. Do not continuously activate for longer than one minute.

Low-Frequency (50/60 Hz) Leakage Current

Enclosure source current, ground open	< 300 µA
Source current, patient leads, all outputs	Normal polarity, intact ground: < 10 µA Normal polarity, ground open: < 50 µA Reverse polarity, ground open: < 50 µA Mains voltage on applied part: < 50 µA
Sink current at high line, all inputs	< 50 µA

High-Frequency (RF) Leakage Current

	Measured with leads recommended by Covidien	Measured directly at the system terminals
Bipolar RF leakage current	< 59.2 mA RMS	< 59.2 mA RMS
Monopolar RF leakage current	< 150 mA RMS	< 100 mA RMS
LigaSure leakage	< 132 mA RMS	< 100 mA RMS

Input Power

100–120 Volt	220–240 Volt
Maximum VA: 1056 VA	Maximum VA: 2080 VA
Input mains voltage, full regulation range: 90 VAC – 132 VAC	Input mains voltage, full regulation range: 208 VAC – 264 VAC
Input mains voltage, operating range: 85 VAC – 132 VAC	Input mains voltage, operating range: 170 VAC – 264 VAC
Mains line frequency range (nominal): 50 Hz – 60 Hz	Mains line frequency range (nominal): 50 Hz – 60 Hz
Fuses (2): 5 mm x 20 mm 8 A, 250 V fast blow	Fuses (2): 5 mm x 20 mm 8 A, 250 V fast blow

Power Cord Specification

This system is factory equipped with a 110 VAC hospital-grade NEMA 5-15 power cord. Should the AC power cord need to be replaced to match another plug configuration, the replacement plug/cable/receptacle configuration must meet or exceed the following specifications:

100-120 VAC

Cable - SJT16/3, IEC color code, maximum length 15 ft. (5 m)
Plug - minimum 10 A - 125 VAC
Unit receptacle - IEC female, minimum 10 A - 125 VAC

220-240 VAC

Cable - H05VVF3G1.0 VDE, maximum length 15 ft. (5 m)
Plug - minimum 6 A - 250 VAC
Unit receptacle - IEC female, minimum 6 A - 250 VAC

Important

Contact your local Covidien representative for alternative internationally approved power-cord options.

Input Frequency

The system operates within specification at all line-input frequencies between 48 Hz and 62 Hz. The user does not need to reconfigure the system for different line frequencies.

Input Current

The system draws no more than 10 A continuous at input voltages between 100 V and 240 V.

Backup Power

The system retains all user programmed features, calibration, and statistical data when switched off and unplugged. The system operates within specification when switched over to a supplied-line power by hospital backup systems.

Equipotential Ground Connection

An equipotential ground connection is provided to allow connection of the system to ground.

ECG Blanking

An ECG blanking port is provided to signal other devices that the system is active. The receptacle is a 2.5 mm mono jack. It is electrically isolated from the internal ground referenced electronics with the shell electrically connected to the chassis for ESD protection.

Standards and IEC Classifications

The ForceTriad energy platform meets all pertinent clauses of the IEC 60601-1 second edition and IEC 60601-2-2 third edition.

ATTENTION
Consult accompanying documents.

The system output is floating (isolated) with respect to ground.

DANGER
Explosion risk if used with flammable anesthetics.

To reduce the risk of electric shock, do not remove the cover. Refer servicing to qualified service personnel.

Unit produces non-ionizing radiation.

Classified with respect to electrical shock, fire, and mechanical hazards only in accordance with UL60601-1 and CAN/CSA C22.2 No. 601.1.

Classified with respect to electrical shock, fire, and mechanical hazards only in accordance with UL standard 60601-1; certified to CSA standard C22.2 No. 601.1.

Equipment should not be disposed of in trash.

Symbols

Monopolar instrument receptacle

Monopolar footswitching receptacle

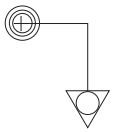
Bipolar instrument receptacle

LigaSure related receptacle or footswitch

Color-coded LigaSure footswitch symbol for matching rear panel connector to front panel receptacle

REM patient return electrode receptacle

Volume adjustment for activation tones



Equipotential grounding point

Class I Equipment (IEC 60601-1)

Accessible conductive parts cannot become live in the event of a basic insulation failure due to the way in which they are connected to the protective earth conductor.

Type CF Equipment (IEC 60601-1)/Defibrillator Proof

The ForceTriad energy platform provides a high degree of protection against electric shock, particularly regarding allowable leakage currents. It is type CF isolated (floating) output and may be used for procedures involving the heart.

This system complies with the ANSI/AAMI HF18 specifications for "defibrillator proof" designation and IEC 60601-2-2.

Liquid Spillage (IEC 60601-2-2 Clause 44.3)

The ForceTriad energy platform is constructed so that liquid spillage in normal use does not wet electrical insulation or other components which when wetted are likely to adversely affect the safety of the equipment.

Voltage Transients (Emergency System Mains Transfer)

The ForceTriad energy platform continues to operate normally with no errors or system failures when transfer is made between line AC and an emergency system voltage source. (IEC 60601-2-2 sub-clause 51.101 and AAMI HF18 sub-clause 4.2.2)

Electromagnetic Compatibility (IEC 60601-1-2 and IEC 60601-2-2)

The ForceTriad energy platform complies with the appropriate IEC 60601-1-2 and 60601-2-2 specifications regarding electromagnetic compatibility.

Notice
The system should not be used adjacent to or stacked with equipment other than specified in the *ForceTriad Energy Platform User Guide* and *Service Manual*. If adjacent or stacked use is necessary, the system should be observed to verify normal operation in the configuration in which it will be used.
The system intentionally applies RF energy for diagnosis or treatment during activation. Observe other electronic medical equipment in the vicinity during the system activation for any possible adverse electromagnetic effects. Ensure adequate separation of electronic medical equipment based on observed reactions.
The use of accessories, other than specified in the *ForceTriad Energy Platform User Guide* and *Service Manual*, may result in increased emissions or decreased immunity of the system.

The ForceTriad energy platform meets the following requirements:

ESD Immunity (IEC 60601-1-2 Sub-Clause 36.202 and IEC 61000-4-2)

Radiated Immunity (IEC 60601-1-2 sub-clause 36.202.2 and IEC 61000-4-3)

Electrical Fast Transient/Burst (IEC 60601-1-2 sub-clause 36.202.3.1 and IEC 61000-4-4)

Surge Immunity (IEC 60601-1-2 sub-clause 36.202.3.2 and IEC 61000-4-5)

Emissions (IEC 60601-1-2 sub-clause 36.201.1, IEC 60601-2-2 sub-clause 36 and CISPR 11 Class A)

Harmonic distortion (IEC 60601-1-2 sub-clause 36.201.3.1 and IEC 61000-3-2)

Conducted disturbances (IEC 60601-1-2 sub-clause 36.202.6 and IEC 61000-4-6)

Power frequency magnetic fields (IEC 60601-1-2 sub-clause 36.202.8.1 and IEC 61000-4-8)

Voltage dips, short interruptions and variations (IEC 60601-1-2 sub-clause 36.202.7 and IEC 61000-4-11)

Guidance and manufacturer's declaration - electromagnetic emissions

The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the system should ensure that it is used in such an environment.

Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 2	The ForceTriad energy platform must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
RF emissions CISPR 11	Class A	The ForceTriad energy platform is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/flicker emissions IEC61000-3-3	Complies	

Guidance and manufacturer's declaration - electromagnetic immunity			
The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the system should ensure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	+/-6 kV contact +/-8 kV air	+/-6 kV contact +/-8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	+/-2 kV for power supply lines +/-1 kV for input/ output lines	+/-2 kV for power supply lines +/-1 kV for input/ output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	+/-1 kV differential mode +/-2 kV common mode	+/-1 kV differential mode +/-2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% U_T (>95% dip in U_T) for 0,5 cycle 40% U_T (>60% dip in U_T) for 5 cycles 70% U_T (>30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 sec	<5% U_T (>95% dip in U_T) for 0,5 cycle 40% U_T (>60% dip in U_T) for 5 cycles 70% U_T (>30% dip in U_T) for 25 cycles <5%U_T (>95% dip in U_T) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user of the ForceTriad energy platform requires continued operation during power mains interruptions, it is recommended that the system be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE: U_T is the a.c. mains voltage prior to the application of the test level.			

<table>
<tr><th colspan="4">Guidance and manufacturer's declaration - electromagnetic immunity</th></tr>
<tr><td colspan="4">The ForceTriad energy platform is intended for use in the electromagnetic environment specified below. The customer or the user of the system should assure that it is used in such an environment.</td></tr>
<tr><th>Immunity test</th><th>IEC 60601 test level</th><th>Compliance level</th><th>Electromagnetic environment - guidance</th></tr>
<tr><td>Conducted RF
IEC 61000-4-6

Radiated RF
IEC 61000-4-3</td><td>3 V RMS
150 kHz to
80 MHz

3 V/m
80 MHz to 2.5 GHz</td><td>3 V

7 V/m</td><td>Portable and mobile RF communications equipment should be used no closer to any part of the ForceTriad energy platform, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.

Recommended separation distance

d=0.5√ P

d=0.5√P 80 MHz to 800 MHz
d=√P 800 MHz to 2.5 GHz

Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than the compliance level in each frequency range.

Interference may occur in the vicinity of equipment marked with the following symbol:  </td></tr>
<tr><td colspan="4">Continued</td></tr>
</table>

NOTE 1 At a 80 MHz and 800 MHz, the higher frequency range applies. **NOTE 2** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.
a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the ForceTriad energy platform is used exceeds the applicable RF compliance level above, the ForceTriad energy platform should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the ForceTriad energy platform. **b.** Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 7 V/m.

Recommended separation distances between portable and mobile RF communication equipment and the ForceTriad energy platform

The ForceTriad energy platform is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The Customer or the user of the system can help prevent electromagnetic interferences by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the system as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter (W)	**Separation distance according to frequency of transmitter (m)**		
	150 kHz to 80 MHz d=0.5√P	**80 MHz to 800 MHz d=0.5√P**	**800 MHz to 2.5 GHz d=√P**
0.01	0.05 m	0.05 m	0.1 m
0.1	0.16 m	0.16 m	0.32 m
1	0.5 m	0.5 m	1 m
10	1.6 m	1.6 m	3.2 m
100	5 m	5 m	10 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Output Characteristics

Maximum Output for Bipolar, Monopolar, and LigaSure Modes

Power readouts agree with actual power into rated load to within 15% or 5 W, whichever is greater.

Caution

To avoid injury to the patient or surgical team, use only instruments rated for use at, or greater than, the maximum peak voltages listed below. For example, bipolar instruments must have voltage ratings of 250 V peak or greater, as shown in the "Open Circuit Peak Voltage (max)" column.

Mode	Open Circuit Peak Voltage (max)	Open Circuit P–P Voltage (max)	Rated Load (max)	Power (max)	Crest Factor*	Duty Cycle
Bipolar						
Low	250 V	500 V	100 Ω	95 W	1.42	N/A
Standard	175 V	350 V	100 Ω	95 W	1.42	N/A
Macro	250 V	500 V	100 Ω	95 W	1.42	N/A
Monopolar Cut						
Cut	1050 V	2100 V	300 Ω	300 W	1.42	N/A
Blend	1485 V	2970 V	300 Ω	200 W	2.7	50%
Valleylab (HWD)	2365 V	4730 V	300 Ω	200 W	4.3	25%
Monopolar Coag						
Fulgurate	3050 V	6100 V	500 Ω	120 W	5.55	6.5%
Spray	3625 V	7250 V	500 Ω	120 W	6.6	4.6%
LigaSure	287.5 V	575 V	20 Ω	350 W	1.42	N/A
LigaSure Test	147.5 V	295 V	20 Ω	190 W	1.42	N/A

* An indication of a waveform's ability to coagulate bleeders without a cutting effect.

Available Power Settings in Watts

Autobipolar (All Modes)

5 W to 40 W available in 1 W increments

				5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 95 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

Bipolar (All Modes)

1 W to 40 W available in 1 W increments

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 95 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

Monopolar Cut

1 W to 40 W available in 1 W increments

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 95 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

100 W to 300 W available in 10 W increments

	100	110	120	130	140	150	160	170	180
190	200	210	220	230	240	250	260	270	280
290	300								

Monopolar Blend

1 W to 40 W available in 1 W increments

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 95 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

100 W to 200 W available in 10 W increments

	100	110	120	130	140	150	160	170	180
190	200								

Valleylab

1 W to 40 W available in 1 W increments

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 95 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

100 W to 200 W available in 10 W increments

	100	110	120	130	140	150	160	170	180
190	200								

Monopolar Coag

1 W to 40 W available in 1 W increments

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

45 W to 90 W available in 5 W increments

45	50	55	60	65	70	75	80	85	90
95									

100 W to 120 W available in 10 W increments

	100	110	120	100	120

Output Waveforms

Tissue Sensing Technology, an automatic adjustment, controls all modes. As tissue resistance increases from zero, the system outputs constant current followed by constant power followed by constant voltage. The maximum output voltage is controlled to reduce capacitive coupling and video interference and to minimize sparking.

Bipolar

Low	472 kHz sinusoid continuous
Standard	472 kHz sinusoid continuous
Macro	472 kHz sinusoid continuous

Monopolar Cut

Cut	472 kHz sinusoid continuous
Blend	472 kHz bursts of sinusoid, recurring at 26.21 kHz intervals. 50% duty cycle.

Valleylab

Valleylab	472 kHz bursts of sinusoid, recurring at 28.3 kHz intervals. 25% duty cycle.

Monopolar Coag

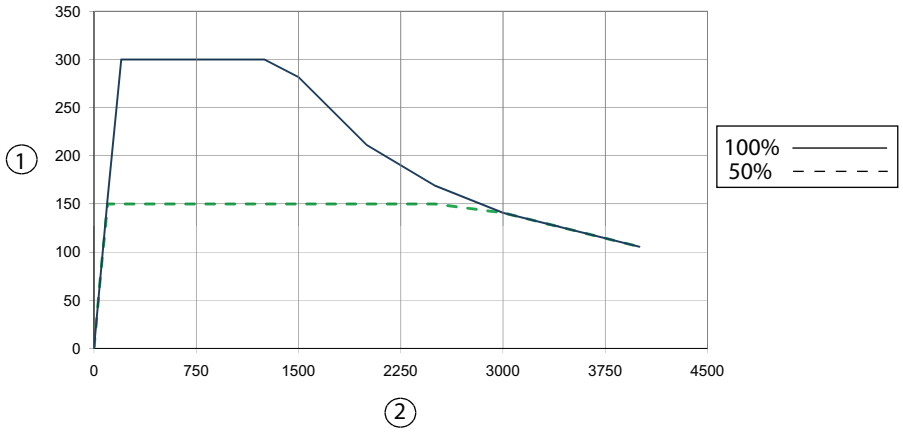
Fulgurate	472 kHz damped sinusoidal bursts with a repetition frequency of 30.66 kHz. 6.5% duty cycle.
Spray	472 kHz damped sinusoidal bursts with a randomized repetition centered at 21.7 kHz. 4.6% duty cycle.

Output Power vs. Resistance Graphs

Monopolar Graphs

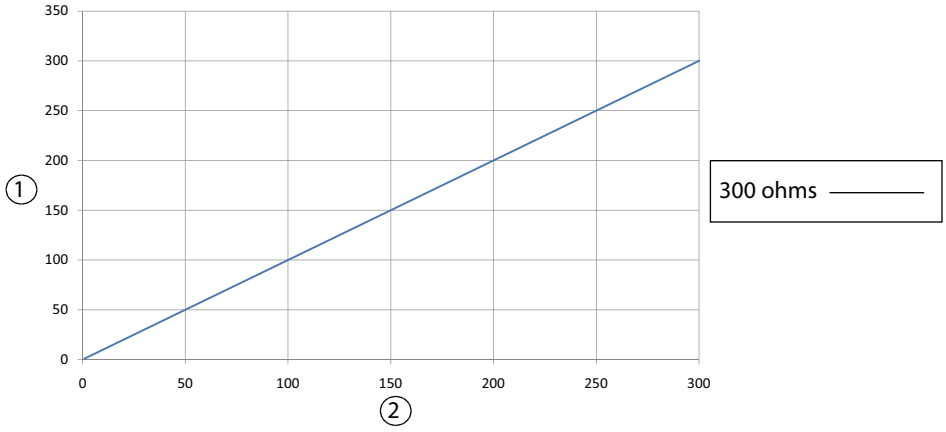
Pure Cut

Output power versus impedance for Pure cut power



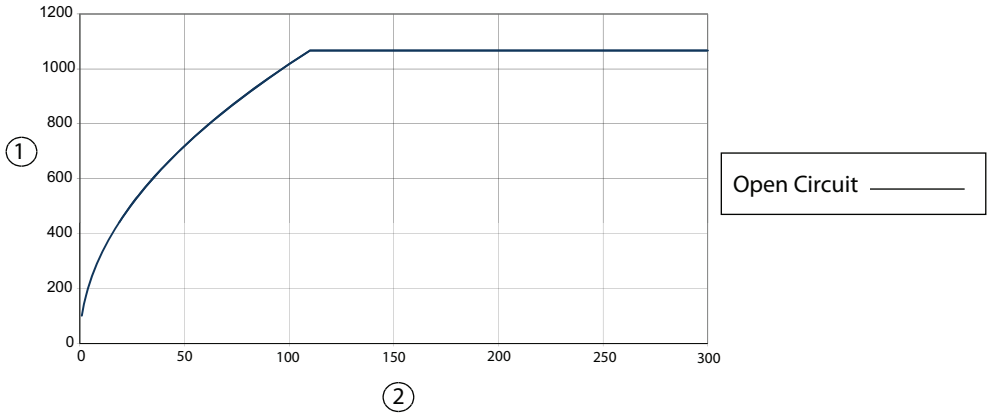
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Pure cut power



① Output power (watts)
② Power setting

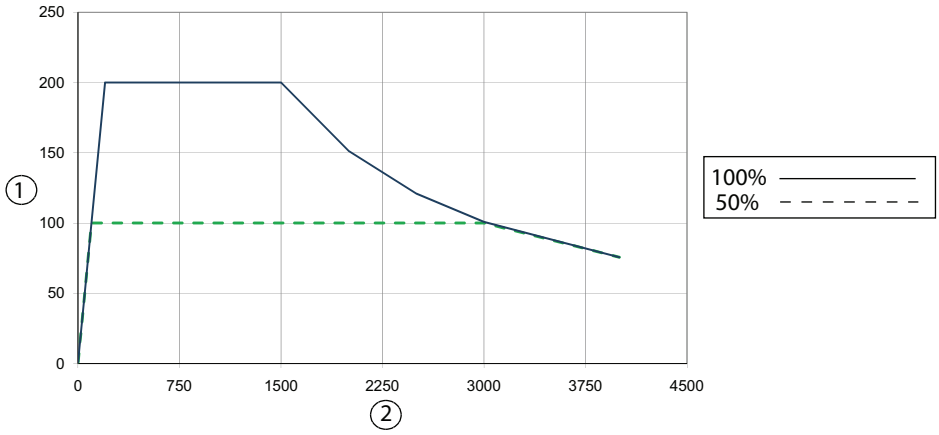
Peak voltage versus power setting for Pure cut power



① Peak voltage
② Power setting

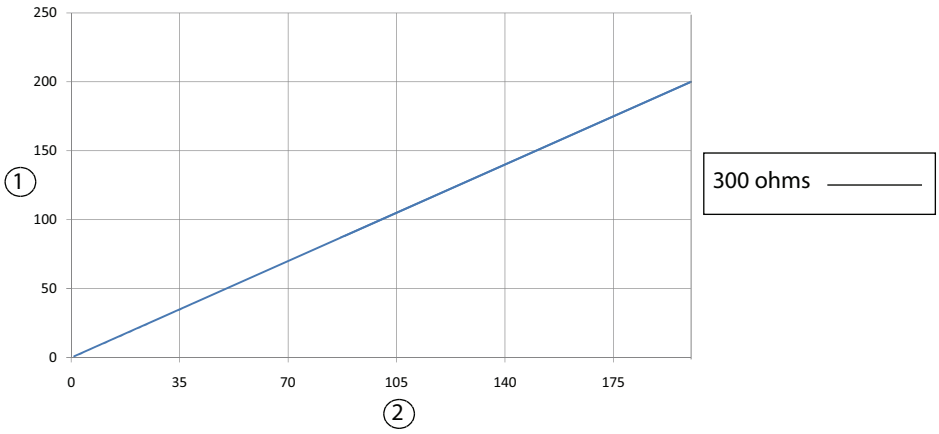
Blend

Output power versus impedance for Blend power



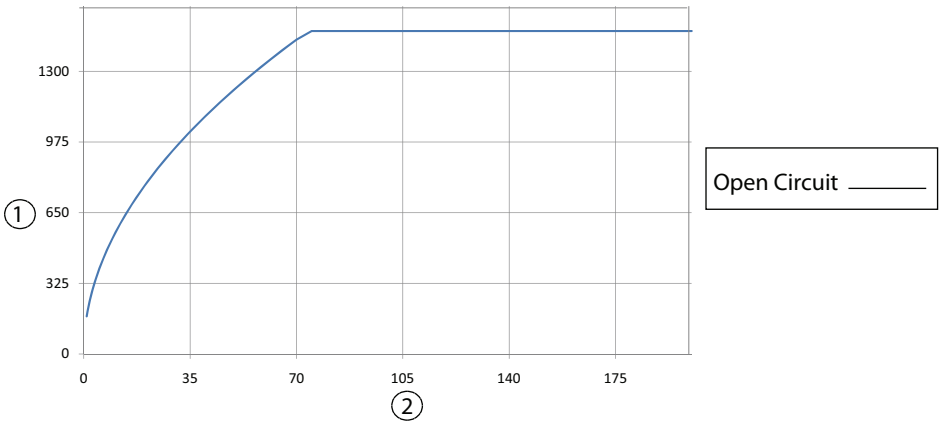
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Blend power



① Output power (watts)
② Power setting

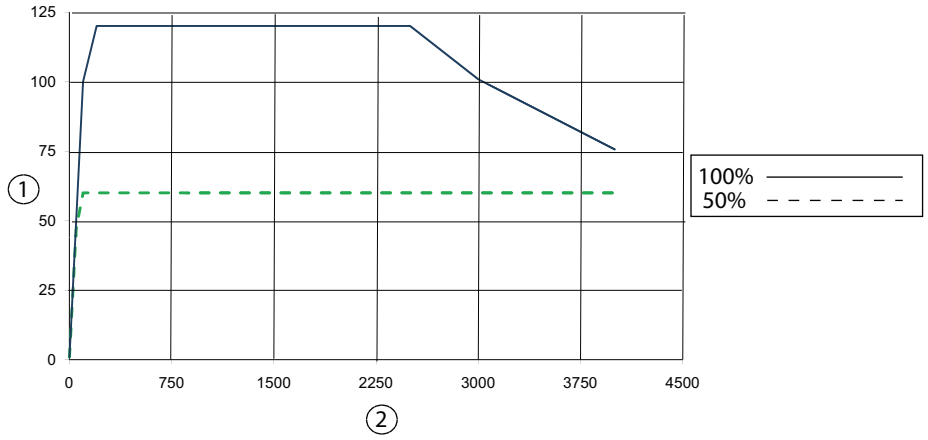
Peak voltage versus power setting for Blend power



① Peak voltage
② Power setting

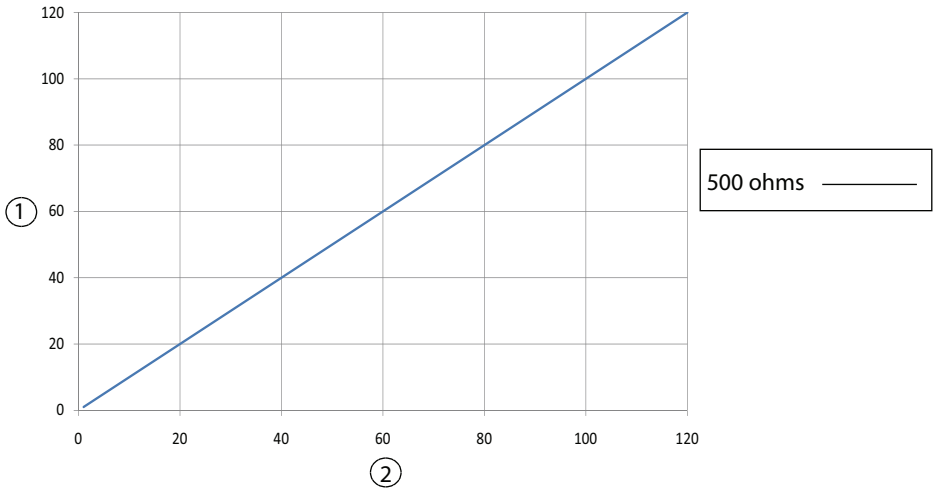
Fulgurate

Output power versus impedance for Fulgurate power



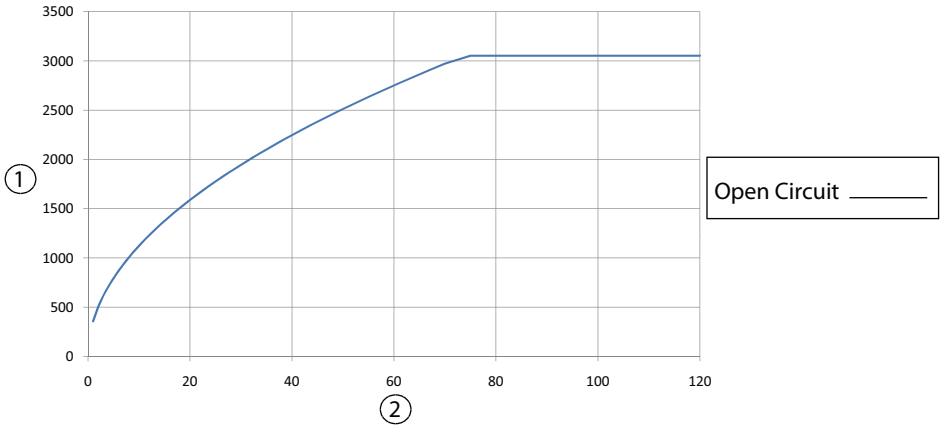
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Fulgurate power



① Output power (watts)
② Power setting

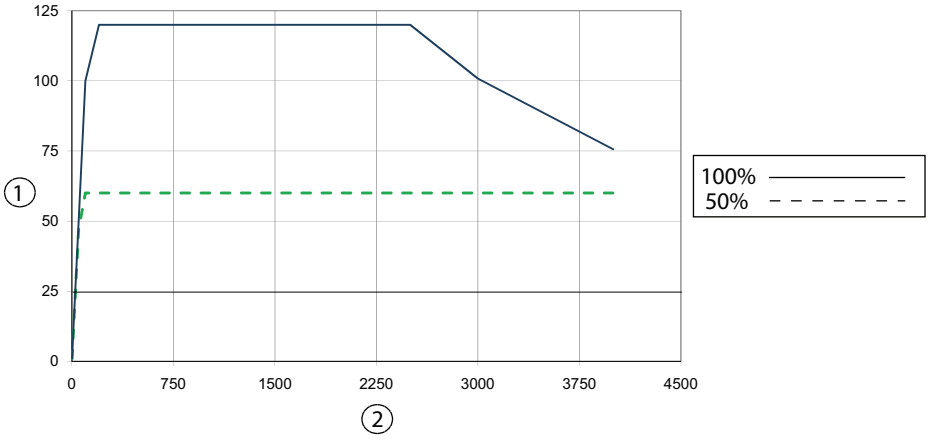
Peak voltage versus power setting for Fulgurate power



① Peak voltage
② Power setting

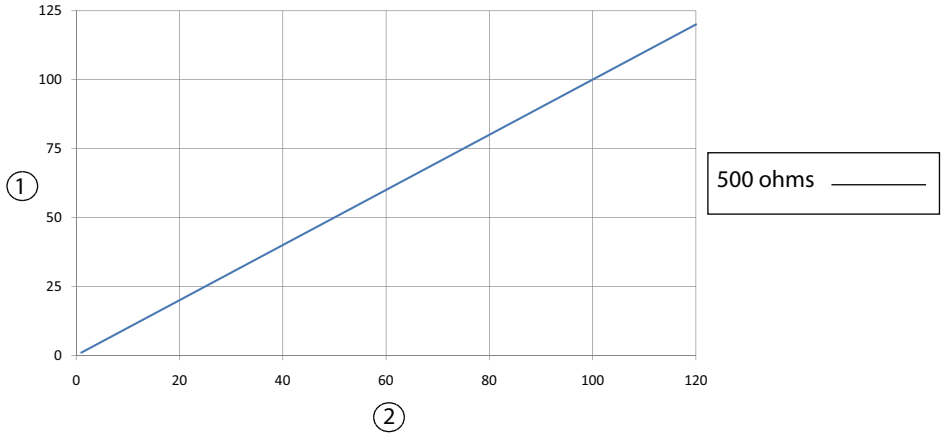
Spray

Output power versus impedance for Spray power



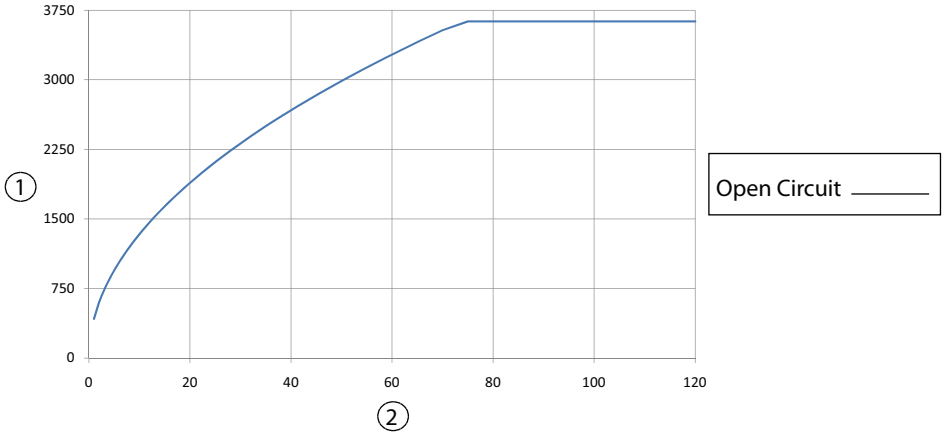
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Spray power



① Output power (watts)
② Power setting

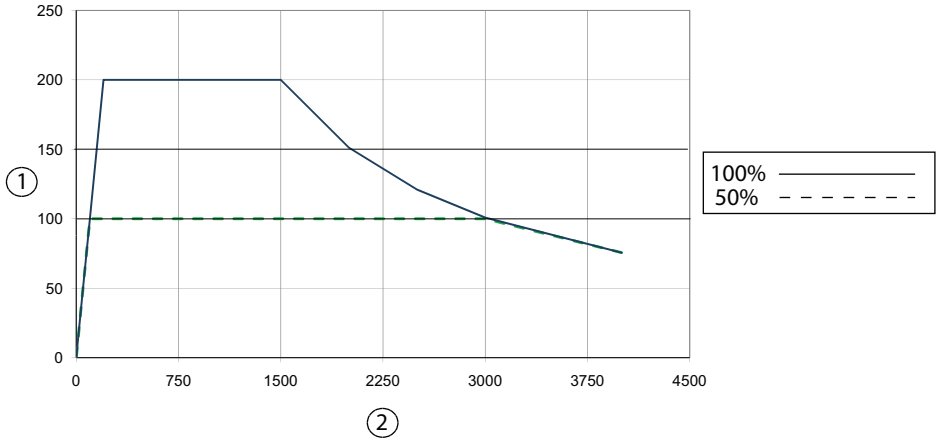
Peak voltage versus power setting for Spray power



① Peak voltage
② Power setting

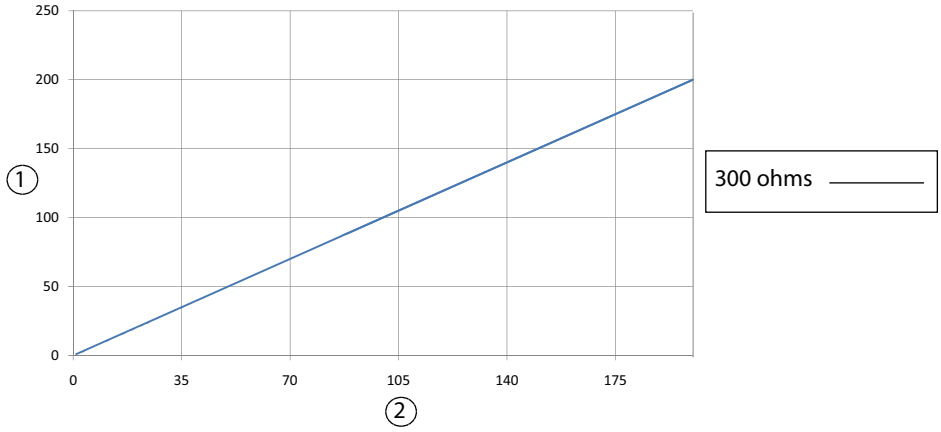
Valleylab

Output power versus impedance for Valleylab power



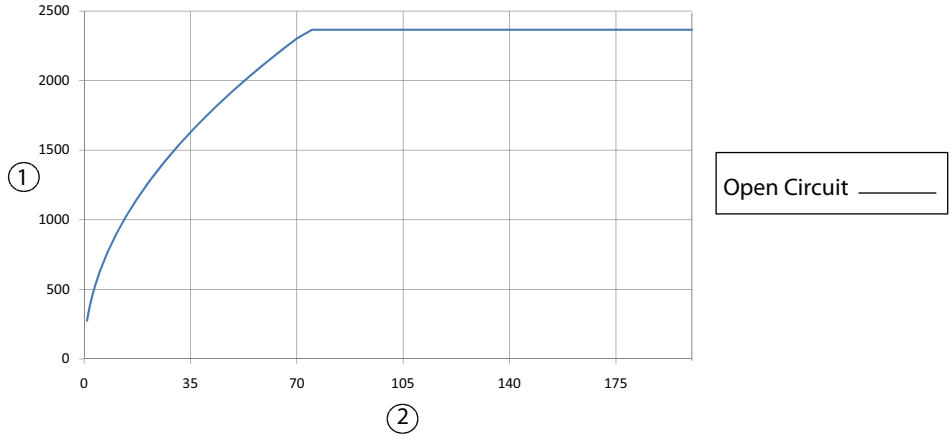
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Valleylab power



① Output power (watts)
② Power setting

Peak voltage versus power setting for Valleylab power

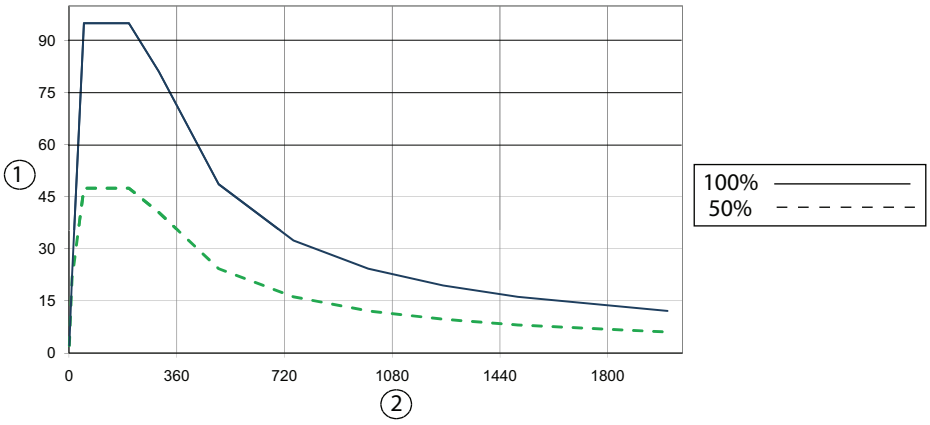


① Peak voltage
② Power setting

Bipolar Graphs

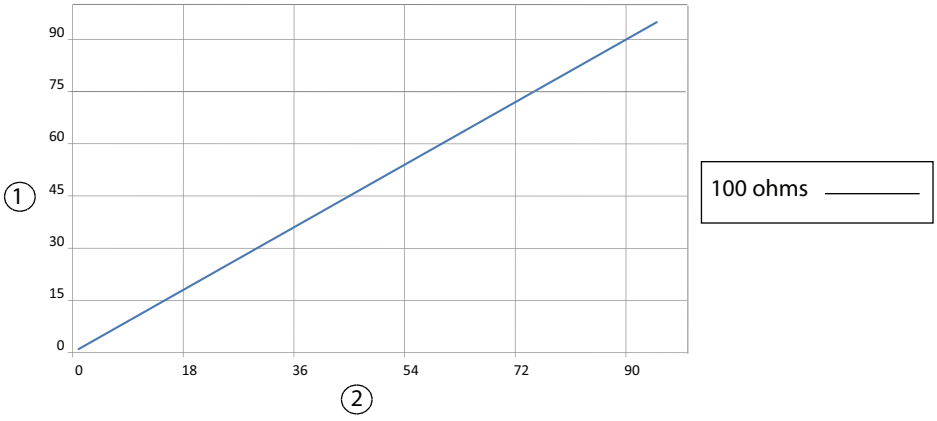
Bipolar Low

Output power versus impedance for Bipolar Low power



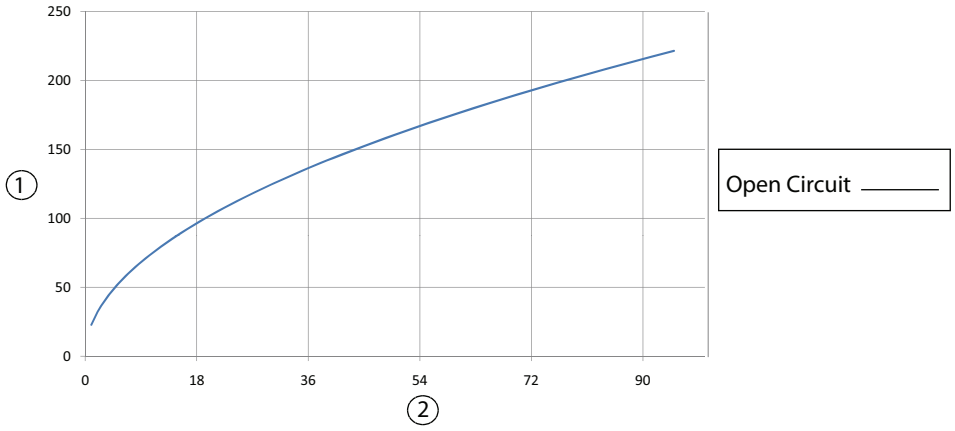
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Bipolar Low power



① Output power (watts)
② Power setting

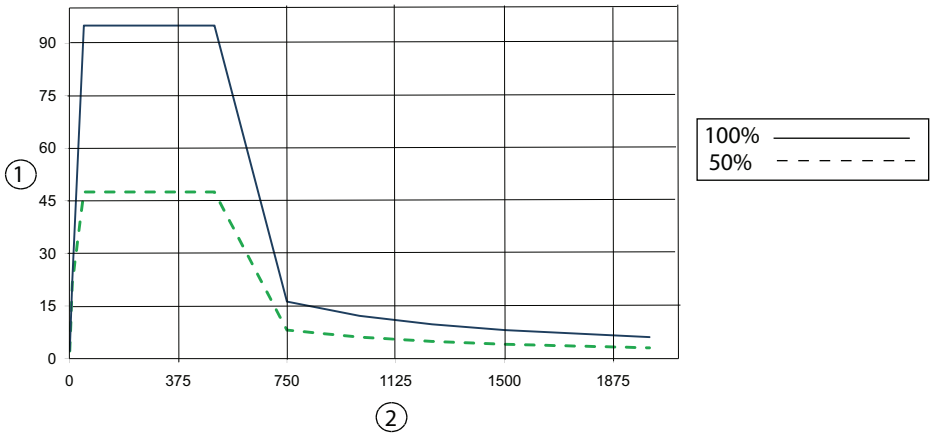
Peak voltage versus power setting for Bipolar Low power



① Peak voltage
② Power setting

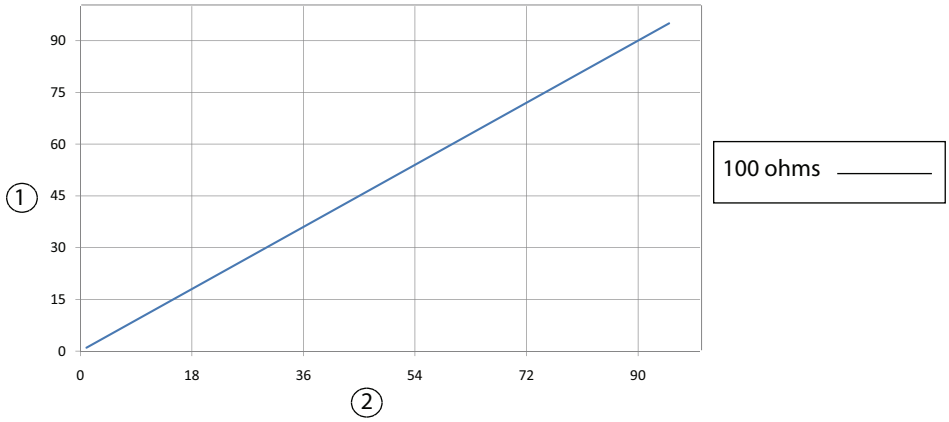
Bipolar Standard

Output power versus impedance for Bipolar Standard power



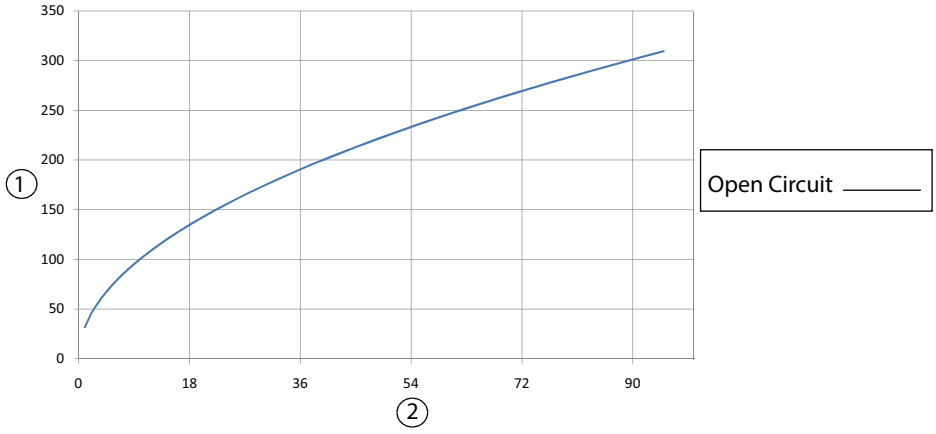
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Bipolar Standard power



① Output power (watts)
② Power setting

Peak voltage versus power setting for Bipolar Standard power

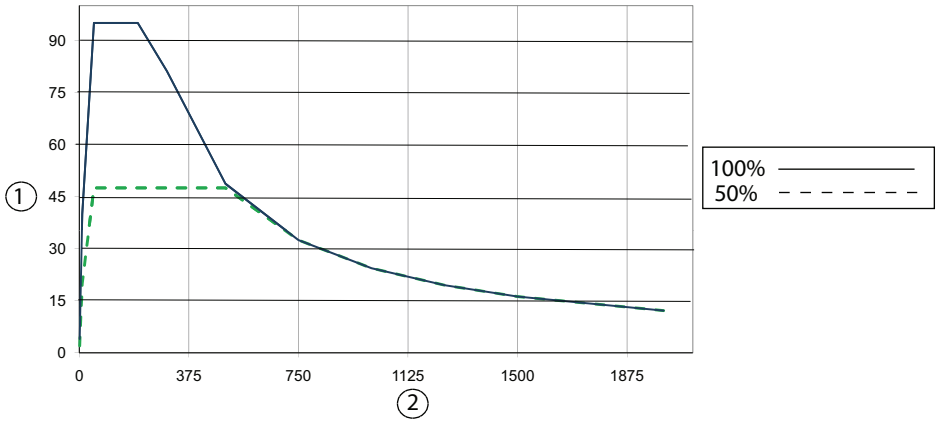


① Peak voltage
② Power setting

Note: Maximum peak voltage in the Bipolar Standard mode occurs at 500 Ω, not open circuit.

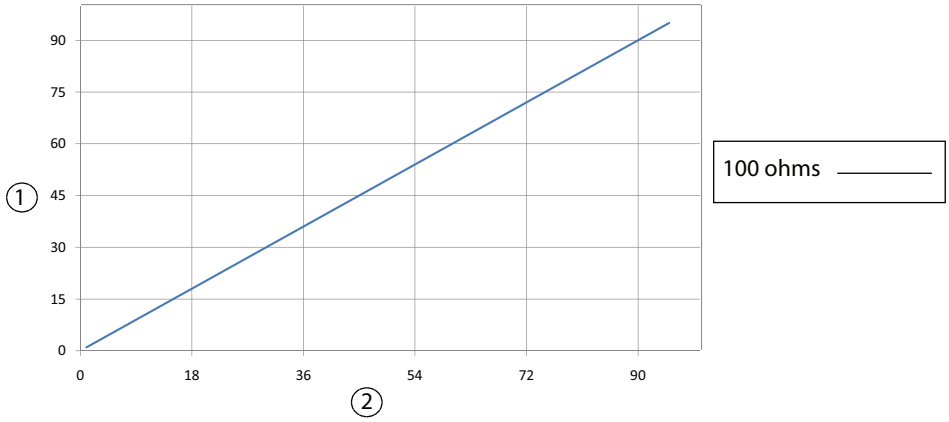
Bipolar Macro

Output power versus impedance for Bipolar Macro power



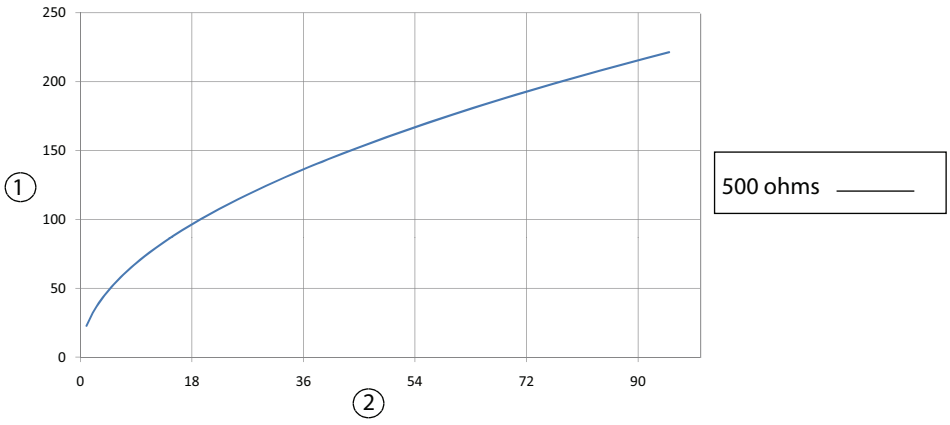
① Output power (watts)
② Load impedance (ohms)

Output power versus power setting for Bipolar Macro power



① Output power (watts)
② Power setting

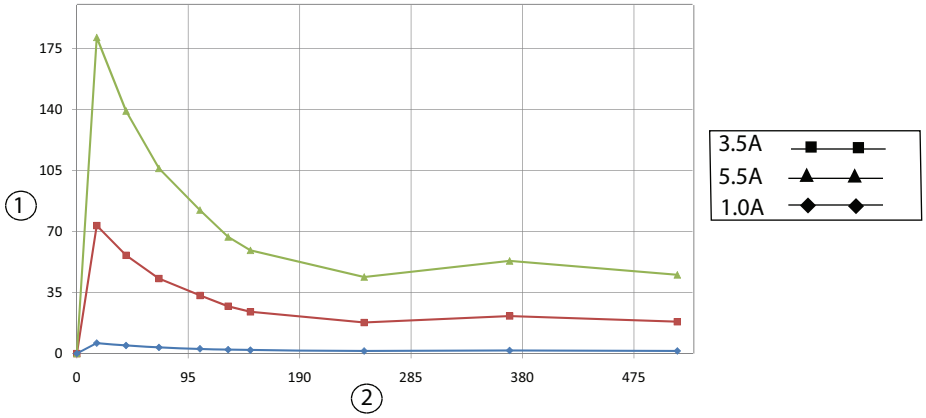
Peak voltage versus power setting for Bipolar Macro power



① Peak voltage
② Power setting

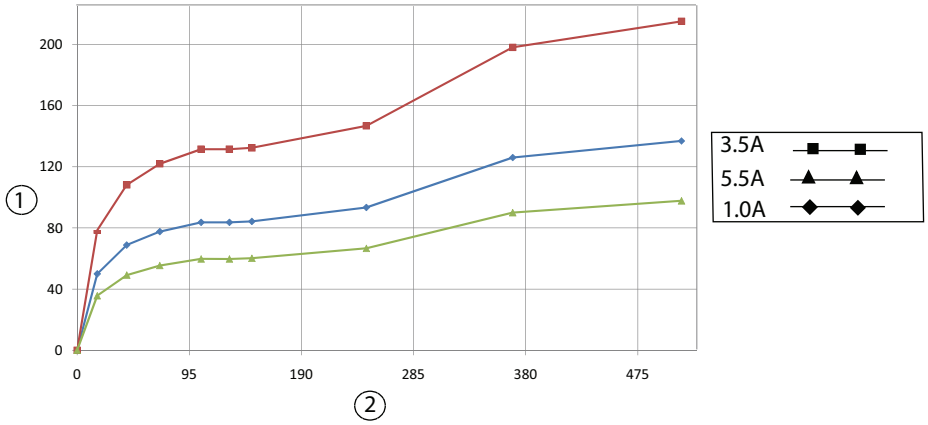
LigaSure

Output power versus impedance for LigaSure power



① Output power (watts)
② Load impedance (ohms)

Peak voltage versus impedance for LigaSure power



① Peak voltage
② Load impedance (ohms)

Chapter 5

System Setup

This chapter describes how to set up the ForceTriad energy platform, turn it on, and configure system settings.

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Setup

Before Startup

1. Verify the system is off by pressing the power switch off (O).
2. Place the system on a flat, stable surface such as a table, platform, boom system, or ForceTriad cart. Refer to the procedures for your local institution or your local codes.
3. Plug the system power cord into the rear panel receptacle.
4. Plug the system power cord into a grounded power receptacle.

   Note: Do not plug into a power strip or extension cord.

Powering Up the ForceTriad Energy Platform

1. Turn on the system by pressing the power switch on (|). Observe the following during the power-up self-test:
   - The Covidien logo appears on all three screens.
   - A blue status bar indicates activity.
   - An hourglass icon indicates activity after the status bar disappears.
   - The system revision code appears on the center screen.
   - A tone sounds upon completion of self-test.
2. If the system does not pass the power-up self-test and an error code is displayed, refer to Chapter 7, *Troubleshooting*.

System Functions

Adjusting Display Brightness

The system screens have two levels of brightness. Touch the brightness icon on the right side of the right touchscreen to adjust the display brightness.

The high and low brightness settings can be changed in Brightness Calibration as explained on page 6-7.

Activation Log

The Activation Log allows the user to view the last 1000 activations and REM alerts.

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.
2. Touch **Activation Log** on the Main menu. The activation log appears on the center touchscreen.
3. Touch the single up or down arrow to the right of the activation log to scroll through the log one line at a time.
4. Touch the green arrow button on the bottom-right corner of the Main menu to return to the previous setup configuration. The previous settings are displayed.

Service Display

Refer to Chapter 9, *Maintenance and Repair* for complete service instructions.

Restore

Select the **Restore** button on the Main menu to restore the system to the previous setup configuration. The touchscreens display the last settings entered prior to shutting down the system.

Setup

The Setup menu allows the user to change the language displayed on the touchscreens, set the time and date, and access the Features menu.

Language Setup

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.
2. Touch **Setup** on the Main menu. The Setup display appears in the left touchscreen.
3. Touch **Language** on the Setup menu. A list of languages appears in the left touchscreen.
4. Touch the single up or down arrow to the right of the list to scroll through the list one line at a time.

   or

   Touch the double up or down arrows to scroll through the list one page at a time.
5. Touch the desired language. A confirmation box appears with a request to confirm that a language change is desired.
6. To proceed with the language change, touch the green check-mark button. The language is activated, and the confirmation box closes.

   or

   To reject the language change, touch the red X button. The language setting returns to the previously selected language.
7. Touch the green arrow button to return to the Setup menu.
8. Touch the green arrow button below the Setup menu to return to the Main menu.

Time and Date Setup

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.
2. Touch **Setup** on the Main menu. The Setup display appears in the left touchscreen.
3. Touch the **Time and Date** button in the Setup menu. The time and date display appears in the left touchscreen.
4. Touch the desired numeric field (minutes, seconds, month, day, or year) to select that field.
5. Touch the up or down arrows next to the time or date row to adjust the selected numeric field.

   Touch and hold the arrows to increase the number once a second. After four seconds, the numbers increase once every 100 milliseconds.

6. Touch the green check mark button to store the date and time information, and return to the Setup menu.

   or

   Touch the red X button to return the time and date to the previous settings, and return to the Setup menu.

7. Touch the green arrow button below the Setup menu to return to the Main menu.

Features Menu

The Features menu displays software features and applications that can be enabled or disabled at the system level.

- ***Autobipolar***—Configures automatic activation and cessation of energy from the Auto tab.
- ***Mono 1 Footswitching*** —Enables footswitching control of both handswitching and footswitching devices attached to the Monopolar 1 receptacle.
- ***Other features or applications***—Other features and applications may be on this menu based on special configurations or purchased applications.

The default software settings for autobipolar mode and monopolar 1 footswitching are enabled or disabled at the system level from the Features menu. Once enabled, the feature is available on the affected screen and can be turned on and off.

Autobipolar and monopolar settings selected on the Features menu determine the options available from the Bipolar and Monopolar touch screens. The settings can be turned on and off locally from buttons available on the affected screens.

Autobipolar

Autobipolar mode on the Features menu enables and disables autobipolar function at the system level, controlling whether autobipolar function is available on the Bipolar tab of the center screen.

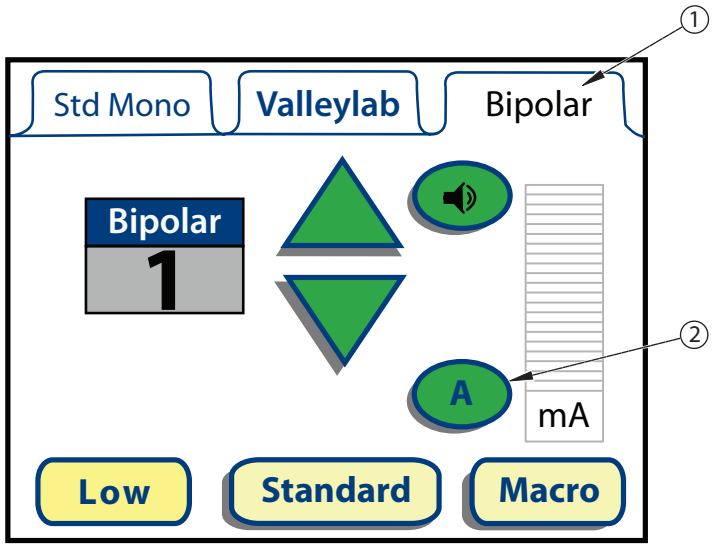
Enable/Disable Autobipolar at the system level:

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.
2. Touch **Setup** on the Main menu. The Setup display appears in the left touchscreen.
3. Touch **Features** in the Setup menu. Available options appear in the left touchscreen. The factory default for all features is disabled.
4. To enable, touch **AutoBipolar**. A check appears in the accompanying box.

   To disable, touch **AutoBipolar**. The check is cleared from the box.

5. Touch the green arrow buttons below the Features menu and Setup menu to return to the Main menu.

   When the AutoBipolar option is enabled, a green (A) button is added to the Bipolar tab in the center screen.



1. Bipolar Tab (This label changes to Auto if autobipolar mode is turned on)
2. Autobipolar Mode Button (shows Autobipolar mode is enabled but not turned on)

Turning Autobipolar Mode On and Off:

Autobipolar mode can be turned on and off on the Bipolar tab if it is enabled from the Features menu.

Note: If enabled on the Features menu, the default setting for autobipolar mode is off.

To turn autobipolar mode on, touch the (A) button on the **Bipolar** screen. The **Bipolar** tab changes to **Auto**, presenting the options and settings for autobipolar mode. For more information see the *ForceTriad Energy Platform User's Guide*.

To turn autobipolar mode off, touch the green **Bipolar** button on the **Auto** tab. The **Auto** tab changes to **Bipolar**.

Mono 1 Footswitching

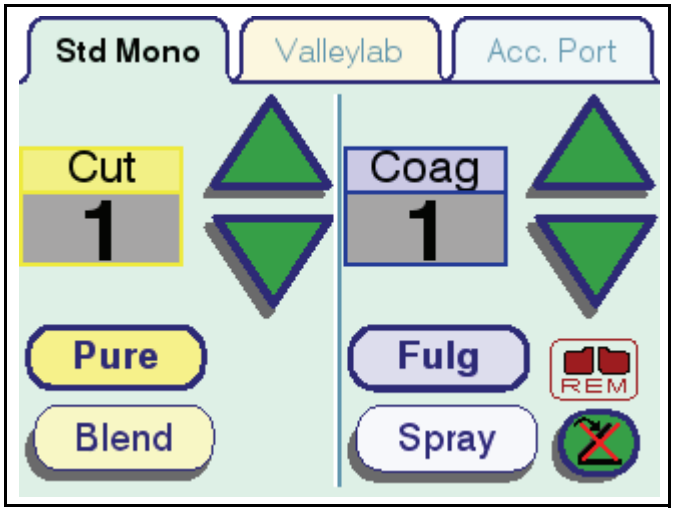
The Monopolar 1 footswitching option on the Features menu enables and disables footswitching on the Monopolar 1 Std Mono and Valleylab tabs. The Accessories Port tab (**Acc. Port**) is not affected. If footswitching is enabled on the Features menu, it can then be turned on and off on the Std Mono and Valleylab tabs.

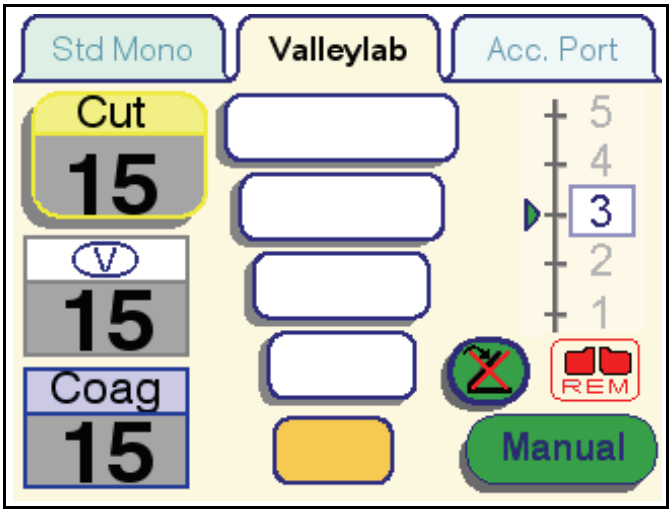
Enabling and Disabling Monopolar 1 Footswitching on the Features menu:

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.
2. Touch **Setup** on the Main menu. The Setup display appears in the left touchscreen
3. Touch **Features** in the Setup menu. Available options appear in the left touchscreen. The default setting for all features is disabled.
4. To enable the feature, touch **Mono 1**. A check appears in the accompanying box.

   To disable, touch **Mono 1**. The check is cleared from the box.
5. Touch the green arrow buttons below the Features menu and Setup menu to return to the Main menu.

When Monopolar 1 footswitching is enabled on the Features menu, the footswitching button with an X appears on the Std Mono and Valleylab tabs in the left screen.





Turning Monopolar 1 Footswitching On and Off:

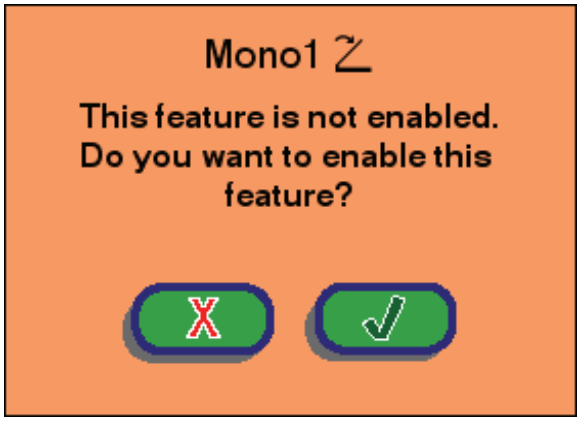
Monopolar 1 footswitching can be turned on and off on the Std Mono and Valleylab tabs as needed if it is enabled on the Features menu.

Note: If enabled on the Features menu, the default setting for Monopolar 1 footswitching is off, as indicated by the red X over the button.

To turn Monopolar 1 footswitching on, touch the footswitch button with the X on the Std Mono or Valleylab tab on the left touchscreen. The red X is removed from the button when turned on.

To turn Monopolar 1 footswitching off, touch the footswitch button on the Std Mono or Valleylab tabs on the left touchscreen. The red X appears on the button when turned off.

Note: If Monopolar 1 footswitch has *not* been enabled, the following touchscreen appears. Enable Monopolar 1 footswitching by touching the button with the green check mark.



Demo Mode

Warning

Demo mode is intended for demonstration purposes only. Demo mode is not intended for clinical use.

Touch the wrench icon on the right side of the right touchscreen. The Main menu display appears in the left touchscreen.

Enable Demo Mode

1. On the Main menu, the Demo mode button displays 'Enter Demo' if the system is not in Demo mode. Touch the **Enter Demo** mode button to begin Demo mode. The system operating displays appear in all the touchscreens with the words 'DEMO MODE: Not for Clinical Use' on all three screens.

   Note: Touching the Demo mode screen removes it briefly from all touchscreens.

2. Proceed with practice or demonstration scenarios. While in Demo mode, the REM alarm and the dual instrument error alarm are deactivated but RF power is still delivered.

   Note: In Demo mode the system does not sense instrument type, so the appropriate tab must be selected manually for the connected instrument.

3. To exit Demo mode, either turn the system off and restart it, or follow the steps in the *Exit Demo Mode* section that follows.

Exit Demo Mode

1. Touch the wrench icon on the right side of the right touchscreen. The Main menu appears in the left touchscreen.
2. On the Main menu, the Demo mode button displays 'Exit Demo' if the system is in Demo mode. Touch the **Exit Demo** button on the Main menu to exit the Demo mode. The system touchscreens display the last settings entered during the Demo mode.

Chapter 6

Setup, Tests, and Adjustments

This chapter describes how to set up, test, and calibrate the ForceTriad energy platform.

After unpacking or servicing the system, set up the system, perform any required calibration, and verify correct functionality.

If the system does not satisfactorily complete the self-test, re-calibrate the system, and power cycle the system. If the system continues to fail the self-test, contact Covidien Customer Service.

This chapter contains tests that are specific for field testing. There are some tests which are performed in the manufacturing environment that are not field requirements. Those tests are not described in this manual.

Setting Up the ForceTriad Energy Platform

Warning

Electric Shock Hazard Connect the system's power cord to a properly grounded receptacle. Do not use power-plug adapters.

Fire Hazard Do not use extension cords.

Caution

Do not stack equipment on top of the system or place the system on top of electrical equipment. These configurations are unstable and/or do not allow for adequate cooling.

Provide as much distance as possible between the electrosurgical system and other electronic equipment (such as monitors). An activated electrosurgical system may cause interference with them.

Notice

If required by local codes, connect the system to the hospital equalization connector with an equipotential cable.

Connect the power cord to a wall outlet having the correct voltage. Otherwise product damage may result.

1. Verify the system is off by pressing the power switch off (O).
2. Place the system on a stable flat surface, such as a table, platform, or Covidien cart. For details, refer to the procedures for your institution or to local codes.

   Provide at least four to six inches of space from the sides and top of the system for cooling. Normally, the top, sides, and rear panel are warm when the system is used continuously for extended periods of time.

   Ensure that the system rests securely on the cart or platform. The underside of the system contains four rubber feet and additional holes that allow you to reposition the feet to ensure stability. Use a Phillips screwdriver to remove the rubber feet from the system. Then, reinstall the feet in the preferred location.
3. According to the procedures used by your institution, connect an equipotential grounding cable to the grounding lug on the rear panel of the system. Then, connect the cable to earth ground.
4. Plug the system power cord into the rear panel receptacle.
5. Plug the system power cord into a grounded receptacle.

6. Turn on the system by pressing the power switch on (|). Verify the following:
   - All visual indicators and displays on the front panel illuminate.
   - Activation tones sound to verify that the speaker is working properly.
7. **If the self-test is successful**, a tone sounds. Verify the following:
   - The three LCD touch screens illuminate and show the appropriate operating screen.
   - Each display shows a power setting.
   - The REM alarm indicator illuminates red.

   or

   If the self-test is not successful, an alarm tone sounds. An error screen appears on each of the LCD touchscreens. Note the information on this display and refer to Chapter 7, *Troubleshooting*.

Calibrating the ForceTriad Energy Platform

There are 11 calibration steps. During calibration the user verifies system-specific information, and adjusts the information if necessary. The user also adjusts the REM circuit and other values that ensure the proper operation of the system.

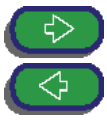
Calibration is not part of preventive maintenance. Calibration is required when components are replaced. Refer to Chapter 8, *Replacement Procedures* to determine the level of required calibration.

Notice

Calibration must be performed on a non-conductive surface. Do not use antistatic bench top mats. When performed on a conductive surface, calibration values may not be accurate.

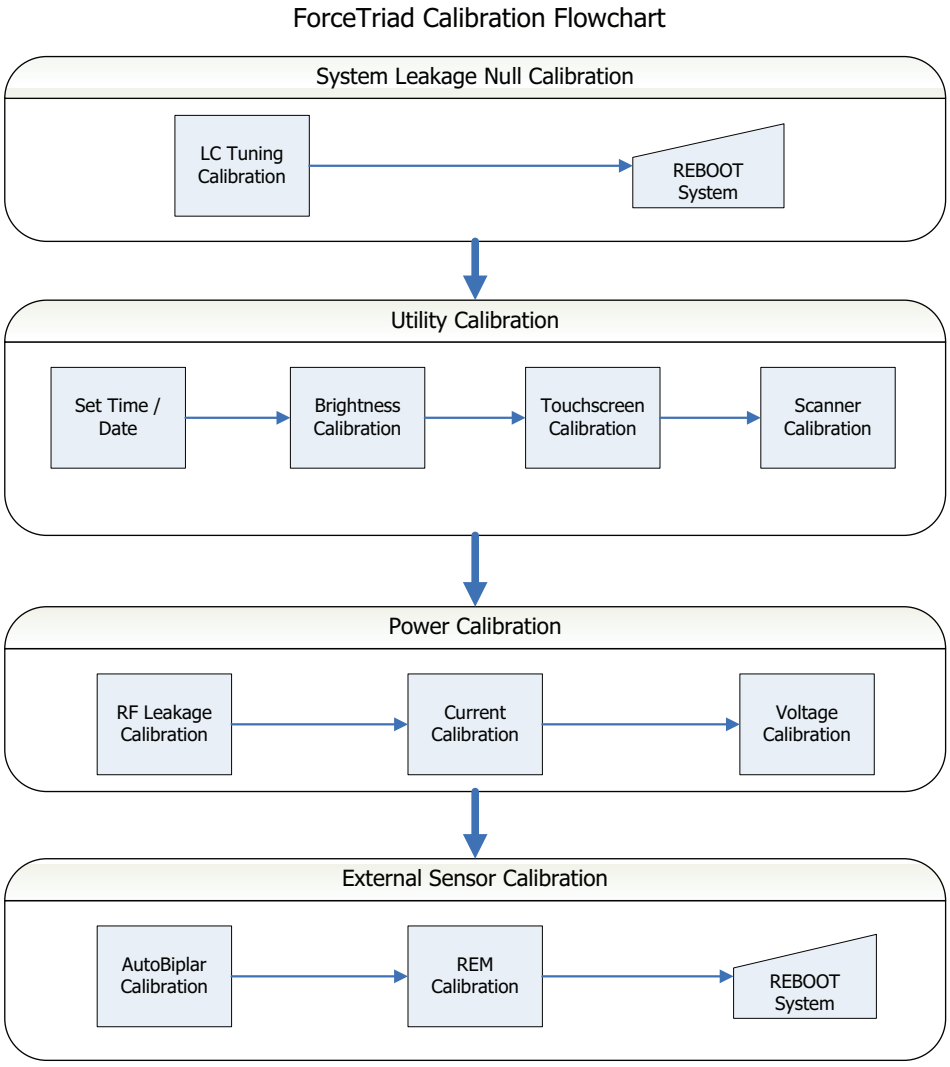
After completing any calibration section, reboot the system to save the values from that calibration section.

Common Calibration Symbols

	**Wrench**
	**Enter**
	**Up/Down**
	**Page Up/Page Down**
	**Next/Back**
	**Cancel**

Calibration Flow Chart

Use the following flow chart to determine the order and level of calibration needed.



Calibration Levels

Chapter 8, *Replacement Procedures* references the calibration levels required after a component replacement. The following table defines calibration level.

Level 0	Periodic safety check
Level 1	Scanner calibration
Level 2	System leakage null calibration
Level 3	System leakage null and utility calibration
Level 4	Power calibration and system leakage null calibration
Level 5	Power calibration, external sensor setup, and system leakage null calibration
Level 6	Full calibration: all sections outlined in the calibration flow chart

System Leakage Null Calibration

Step 1- LC Filter Tuning

1. Turn the system off.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover aside for reinstallation.
3. Connect a cable through a Pearson current monitor from the REM port to the ground lug in the back of the system.
4. Turn the system on.
   a. Touch the wrench icon on the right side of the right screen.
   b. Select the **Service** button.
   c. Enter password 423213 and select the **Enter** button.
   d. Select the **Diagnostics** button.
   e. Select the **Debug Mode** button.
   f. Select the **Mono Blend** button from the drop down list (Mode Selection).
   g. Select the **Mono 1** button from the drop down list (Port Selection).
   h. Select the **Open Loop** button.
   i. Set level to 20% using the **Up** button.
   j. Select the **Start RF** button.
5. Adjust the inductor potentiometer (L2) located on the HVDC PCBA to get the lowest possible reading on the external True RMS meter.

6. Select the **Stop RF** button when the optimal current value has been reached.
7. Turn the system off.
8. Apply Loctite®, or equivalent, to the inductor potentiometer.
9. Reinstall the cover on the system. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
10. Reboot the system to save the calibration data.

Utility Calibration

Step 2- Set Date and Time

1. Turn the system on.
2. Touch the wrench icon on the right side of the right screen.
3. Select the **Setup** button.
4. Select the **Time and Date** button.
5. Adjust time and date using up- and down-arrow keys and select the **Enter** button.
6. Select the **Back** button to return to the Main Menu.

Step 3 - Brightness Calibration

1. Select the **Service** button.
2. Enter password 423213 and select the **Enter** button.
3. Select the **Maintenance** button.
4. Select the **Calibrate** button.
5. Use the up and down arrows to scroll through the calibration menu list and select the **Brightness** button.
6. Follow the on-screen instructions and select the **Next** button to continue with brightness calibration.
7. When the on-screen calibration instructions for each of the three touchscreens have been completed and saved, select the **Next** button to view the Brightness Calibration Parameters.
8. Select the arrow button to save the calibration data.

Step 4 - Touchscreen Calibration

1. Select the **Service** button.
2. Enter password 423213 and select the **Enter** button.
3. Select the **Maintenance** button.
4. Select the **Calibrate** button.
5. Use the up and down arrows to scroll through the calibration menu list and select the **Touch Screen** button.

6. Using a stylus (or equivalent) gently touch the center of the cross-hair targets. Complete all targets from left screen to right screen.
7. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

Step 5 - Scanner Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the **Scanner** button and select the green arrow to proceed. Allow the system to perform an initial scanner calibration on all ports.
2. Follow the on-screen instructions and select the green arrow button to continue with calibration.

   Note: This step requires a LigaSure instrument with a dot pattern on the connector. (A LigaSure instrument with a barcode on the connector will not work.)
3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

Power Calibration

Step 6 - RF Leakage Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the Leakage Calibration button.
2. Follow the on-screen instructions and select the **Next** button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to go to the next calibration step.

Step 7 - Current Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the **Current Calibration** button.
2. Follow the on-screen instructions and select the right-arrow button to continue with calibration.
3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

Step 8 - Voltage Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the **Voltage Calibration** button

Notice
Do not hold down the up or down arrows. Irreversible damage may occur to the system.

2. Follow the on-screen instructions and select the **Next** button to continue with calibration.

   Note: 1000 Ω and 5000 Ω resistors are required for voltage calibration.

3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

External Sensor Calibration

Step 9 - Autobipolar Calibration

Notice

An E0020, E0021, or E0022 cable is required to perform the calibration.

1. Use the up and down arrows to scroll through the calibration menu list and select the **AutoBip Calibration** button.
2. Follow the on-screen instructions and select the **Next** button to continue with calibration using the Autobipolar load box.
3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

Step 10 - REM Calibration

1. Use the up and down arrows to scroll through the calibration menu list and select the **REM Calibration** button.
2. Follow the on-screen instructions and select the **Next** button to continue with calibration using the REM calibrator/decade box.
3. When the on-screen calibration instructions have been completed and saved, select the red **X** button to exit to the next calibration step.

Step 11 - Complete Calibration Process

1. To save the calibration parameters, power cycle the system.

Periodic Safety Check (Routine Maintenance)

Perform the following safety check once a year to verify that the system is functioning properly. Record the test results for reference in future tests. Copy the check sheet at the end of this chapter for use in recording the results. Keep the completed check sheet for future reference. If the system fails to meet any of the checks, refer to Chapter 7, *Troubleshooting*.

Warning

Electric Shock Hazard When taking measurements or troubleshooting the system, take appropriate precautions, such as using isolated tools and equipment, using the "one hand rule", etc.

Electric Shock Hazard Do not touch any exposed wiring or conductive surfaces while the system is disassembled and energized. Never wear a grounding strap when working on an energized system.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Important

When testing RF equipment, follow these test procedures to duplicate manufacturer test data. Keep test leads to the minimum length usable; lead inductance and stray capacitance can adversely affect readings. Carefully select suitable ground points to avoid ground loop error in measurements.

The accuracy of most RF instruments is approximately 1%–5% of full scale. Using uncompensated scope probes causes large errors when measuring high-voltage RF waveforms.

Full definitions of the periodic safety checks are found throughout this section of the manual. A summary of the periodic safety checks is:

- Inspect the system and accessories
- Inspect the internal components
- Test the system
- Verify REM function
- Verify cross coupling
- Confirm outputs
- Check leakage current and ground resistance

Recommended Test Equipment

- Stylus pencil (for calibrating touch screen)
- 5 Ω, 10 Ω, 20 Ω, 30 Ω, 50 Ω, 100 Ω, 200 Ω, 300 Ω, 500 Ω, 1000 Ω, 2000 Ω, and 5000 Ω, all 250 W, 1% tolerance, non-inductive resistive loads
- Current transformer - Volt per Amp equal to 0.10 with 10 MHz Bandwidth
- REM calibrator/decade resistance box (for REM testing)
- REM plug
- Digital voltmeter (3.5 digit minimum)
- Handswitching electrosurgical pencils
- Force TriVerse™ electrosurgical device (barcode)
- Covidien footswitch pedals (bipolar, monopolar, LigaSure)
- Potentiometer adjustment tool
- Low-frequency test circuit
- Test-cable set
- Autobipolar load box
- Autobipolar test cable (E0020, E0021, or E0022)
- True RMS voltmeter

True RMS Voltmeter Specifications

Requirement	Specification
Voltage (RMS)	2.0 - 700.0 mV RMS (Resolution 0.1 mV RMS)
Voltage (Peak)	1000.0 mV (Resolution 0.1 mV)
Frequency	10 KH - 10 MHz
Accuracy	1% Reading
Max Input Voltage	3.3 Vp-p
Current (with 0.1:1 CT)	7000 mA RMS (Resolution 1 mA)
Current (with 1:1 CT)	700.0 mA RMS (Resolution 0.1 mA)
Crest Factor	1.4 to 500 (Resolution 0.1)
Input Impedance	50 ohm

Inspecting the System and Accessories

Equipment required:

- Bipolar footswitch and monopolar footswitch
- Bipolar instrument cords or test leads
- Monopolar instrument cords or test leads
- LigaSure instrument or test leads

Turn off the system, and disconnect the power cord from the wall receptacle.

Rear Panel

1. Check the rear-panel footswitch receptacles for obstructions or damage. Check for a secure fit by inserting the bipolar, monopolar, LigaSure 1, and LigaSure 2 footswitch connector into the appropriate receptacles.
2. Remove the fuse and verify correct voltage and current rating. Refer to *Performance Characteristics* on page 4-2.
3. If any footswitch connector is damaged or unusable, return the system to Covidien Technical Service. For more information, see *Covidien Technical Service* on page 9-4.

Front Panel

1. Check the Universal Footswitching Port (UFP) for obstructions or damage:
   - Check for a secure fit by inserting the UFP adapter into the receptacle.
   - Verify the accessory port tab (Acc. Port) on the Monopolar 1 screen becomes active, indicating the adapter has been detected.

   If the UFP port is damaged or unusable, return the system to Covidien Technical Service. For more information, see *Covidien Technical Service* on page 9-4.
2. Check the Bipolar instrument receptacle for obstructions or damage:
   - Insert the bipolar instrument or cable into the receptacle to verify a secure fit.
   - Verify the Bipolar tab on the Monopolar 2 screen becomes active, indicating the instrument has been detected.

   If the receptacle is damaged, return the system to Covidien Technical Service. For more information, see *Covidien Technical Service* on page 9-4.
3. Check the Monopolar 1 and Monopolar 2 instrument receptacles for obstructions or damage:
   - Insert a standard two-button or Force Triverse electrosurgical pencil into the both receptacles to verify a secure fit.
   - Verify the appropriate tab becomes active, indicating the instrument has been detected:

For the standard two-button electrosurgical pencil, the Standard Monopolar tab (Std Mono) becomes active.

For the Force Triverse electrosurgical pencil, the Valleylab tab becomes active.

If either of the monopolar receptacles is damaged, contact Covidien Technical Service. (see page 9-4).

4. Check the Patient Return Electrode (REM) receptacle for a broken pin or an obstruction.

   If the receptacle is damaged or obstructed, contact Covidien Technical Service (see page 9-4).

5. Check the LigaSure 1 and LigaSure 2 receptacles for obstructions or damage:
   - Insert a LigaSure instrument into each receptacle to ensure a secure fit.
   - Verify the corresponding LigaSure control panel becomes active, indicating the instrument has been detected:

     For the LigaSure 1 receptacle, the LigaSure 1 control panel becomes active.

     For the LigaSure 2 receptacle, the LigaSure 2 control panel becomes active.

   If either receptacle is damaged or the "Invalid Instrument" message appears on either control panel, contact Covidien Technical Service (see page 9-4).

Footswitches

1. Remove the footswitch from the system.
2. Inspect the connector for damage or corrosion.
3. Inspect the footswitch for damage.
4. Reconnect the footswitch to the system.

Power Cord

1. Remove the power cord from the unit and ensure that it is unplugged from the wall receptacle.
2. Inspect the power cord for damage.
3. Reconnect the power cord to the system and wall receptacle.

Inspecting the Internal Components

Equipment required:

- Phillips screwdriver

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

1. Turn off the system.
2. Remove the four screws that secure the cover to the chassis. Lift the cover off the chassis. Set the cover aside for reinstallation.
3. Verify that all connectors are firmly seated.
4. Inspect each PCBA for damaged components, wires, cracks, and corrosion:

   If there is evidence of damage on the Controller PCBA, Steering Relay PCBA, Display PCBA, Footswitch/Audio PCBA, HVDC Power Supply PCBA, or the RF PCBA, contact Covidien Technical Service (see page 9-4).

Testing the System

Turning on the system initiates an internal self-test to verify the calibration. The self-test also checks the operation of the speaker, all indicators, and the displays.

Warning

Use the system only if the self-test has been completed as described. Otherwise, inaccurate power outputs may result.

1. Turn on the system by pressing the front panel On (|) switch. Verify the following:
   - All visual indicators and displays on the front panel illuminate.
   - Activation tones sound to verify that the speaker is working properly.
2. If the self-test is successful, a tone sounds. Verify the following:
   - The three LCD touch screens illuminate and show the appropriate operating screen.
   - The REM alarm indicator illuminates red.

   or

   If the self-test is not successful, an alarm tone sounds. An error screen appears on each of the LCD touchscreens. Note the information on this display and refer to Chapter 7, *Troubleshooting*.

Enable Demo Mode

Many of the tests require the system to be in Demo mode. Refer to the following section to enable and exit Demo mode.

1. To enter demo mode, touch the wrench icon on the right side of the right touchscreen. The Main Menu display appears in the left touchscreen and the Demo mode button displays 'Enter Demo' if the system is *not* in Demo mode.
2. Touch the **Enter Demo** mode button to begin Demo mode. The touchscreens display the words 'DEMO MODE: Not for Clinical Use' on all three screens.

Note: While in Demo mode, the REM alarm and the dual-instrument error alarm are deactivated, but RF power is still delivered. The system does not sense the instrument type, so the appropriate tab must be selected manually for the connected instrument.

3. To exit Demo mode, either turn the system off and restart it, or follow the steps in the *Exit Demo Mode* section that follows.

Exit Demo Mode

1. Touch the wrench icon on the right side of the right touchscreen. The Main Menu display appears in the left touchscreen and the Demo mode button displays 'Exit Demo' if the system is in Demo mode.
2. Touch the **Exit Demo** button to exit Demo mode. The system touchscreens display the last settings entered during Demo mode.

Entering Debug Mode

Many of the tests require the system to be in Debug mode. Refer to the following section to enter and exit Debug mode.

1. To enter Debug mode, select the tool button on the right side of the right screen.
2. Select the **Service** button, enter the password 423213, and select the check marker.
3. Select the **Diagnostics** button.
4. Select the **Debug Mode** button.
5. Debug Screen Setup

There are various inputs the Debug screen requires to properly activate the unit. Refer to the following section to properly set up the Debug screen.

1. *Mode Selection* is the type of output the unit is to perform. This selection is specific to the type of testing being performed.
2. *Port Selection* is the output receptacle to which the energy is to be delivered. This selection is specific to the mode selected
3. *Level* is the power output to be delivered to the selected port. This setting is specific to the port selected.
4. *Start RF Button* is the on/off switch to deliver power. Once the unit is properly set up and the test equipment is in place, the start RF button should be used.

Notice

While in Debug Mode, the Open Or Close Loop selection in the lower-left of the screen should *always* remain in Closed Loop. Open Loop should *never* be used during preventive maintenance of the ForceTriad system. Irreversible damage may occur to the unit if Open Loop control is used improperly.

Testing the Low-Voltage Power Supply

Equipment required:

- DVM

This test is required when the power supply is replaced. This is not part of the preventive maintenance.

1. Plug the system into a nominal ACV line voltage (120 VAC or 220 VAC) and turn on the system.
2. Allow the system to pass the self-test.
3. Using TP82 for the ground, measure the low-voltage DC output on the RF board for:

	Range
+5 VDC (TP81)	5.00 VDC to 5.20 VDC
+12 VDC (TP83)	11.4 VDC to 13.2 VCD
-12 VDC (TP90)	-12.36 VDC to -11.64 VDC

Verifying the Audio

Equipment required:

- 2-button hand switch

1. Enable Demo mode as described in *Enable Demo Mode* on page 6-15.
2. Activate the Mono 1 cut from the hand switch. Verify that the audio is active and distortion free.
3. Rotate the audio knob on the rear of the system from high- to low-volume ranges. Verify that the audio is active and distortion free.

Verifying REM Function

Equipment required:

- REM plug and REM calibrator/decade box

For REM functional tests, *the system must be in clinical mode*, not Demo mode. Allow a minimum of 2 seconds between testing for the system to settle.

1. Set the resistance substitution box to 120 Ω. Connect the resistance box to the system, and confirm that the REM indicator illuminates green.
2. Slowly increase the resistance in 1 Ω increments until the REM alarm sounds. This alarm should sound between 128 Ω and 142 Ω.
3. Decrease the resistance to 60 Ω, and verify that the REM indicator illuminates green.
4. Increase the resistance to 77 Ω, and slowly increase the resistance in 1 Ω increments until the REM alarm sounds. This alarm should sound between 77 Ω and 91 Ω.
5. Decrease the resistance to 30 Ω, and verify that the REM indicator illuminates green.
6. Decrease the resistance to 10 Ω, and verify that the REM indicator illuminates green.
7. Decrease the resistance in 1 Ω decrements until the REM alarm sounds. This alarm should sound before 1 Ω.

Verifying Autobipolar Mode

Equipment required:

- E0020, E0021, or E0022 cable
- Autobipolar load box

For each of the tests:

- Conduct all Autobipolar tests in the Standard bipolar mode.
- Test all Autobipolar activations at power setting 20 W.

Verifying Autobipolar Function

1. Enter the autobipolar mode by pressing the **Tool** button, the **Setup** button, the **Features** button, and then the **AutoBip** button.
2. Verify that the autobipolar function is available in the Low, Macro, and Standard bipolar modes. The system is in autobipolar mode when an **A** button appears in the middle window.
3. Set the bipolar power to 20 W.
4. Verify that the bipolar power setting does not change when the **Auto** button is active or inactive.

Verifying the Footswitch Mode

Notice

This testing requires the Autobipolar test box and an E0020, E0021, or E0022 test cable. Do not do this test step if the required equipment is not available.

1. Press the **Bipolar** tab, press the **A** button in the Bipolar window, press the **Setup** button in the Bipolar window. Press the foot and hand graphic and **Auto** button ensuring you can toggle between the two. Leave the unit in the foot/hand graphic setting.
2. Set the time to 0.0 S.
3. Set the Ω to 2200.
4. Press the back button once to go to the Autobipolar screen.
5. Press the **Standard** button to select the proper mode.
6. Connect a 45 Ω load to the bipolar output. Verify that the RF generation occurs when bipolar is activated.
7. Verify that RF generation continues when the footswitch button is released.
8. Disconnect the load. Verify that RF generation stops.

Verifying Automatic Mode

1. Press the **Bipolar** tab, press the **A** button in the Bipolar window, press the **Setup** button in the Bipolar window, press the **Auto** button. Press the back button once to go to the Autobipolar screen.
2. Connect a 45 Ω load to the bipolar output. Verify that RF generation occurs at 20 W automatically.
3. Disconnect the load. Verify that RF generation stops.
4. Connect a 940 Ω load to the bipolar output. Verify that RF generation occurs at 20 W when the load is connected across the bipolar output.
5. Disconnect the load. Verify that RF generation stops.
6. Connect a 1070 Ω load to the bipolar output. Verify that no RF generation occurs.
7. Disable the Autobipolar function before continuing to the next section.

Verifying Cross Coupling

Equipment required:

- 2-button hand switch
- bipolar foot switch
- bipolar cable
- UFP adapter

- LigaSure test cables

For each of the tests:

- Activate each Monopolar mode either by its hand switch or footswitch connectors.
- Set all modes to their maximum power settings and ensure the system is in Demo mode.
- Ensure that the current is within the specification 0 mA to 140 mA.

1. Mono 1 current. Connect a 200 Ω load from the Mono 1 left tine output through the current transformer to the patient-return port. Activate the following modes one at a time.
   - Mono 2 Cut Pure
   - Mono 2 Coag Spray
2. UFP current. Connect a 200 Ω load from the UFP output through the current transformer to the patient-return port. Activate the following modes one at a time.
   - Mono 2 Cut Pure
   - Mono 2 Coag Spray
3. Mono 2 current. Connect a 200 Ω load from the Mono 2 left tine output through the current transformer to the patient-return port. Activate the following modes one at a time.
   - Mono 1 Cut Pure
   - Mono 1 Coag Spray
4. Bipolar current. Connect a 200 Ω load from the left bipolar output through the current transformer to the right bipolar output. Activate the following modes one at a time.
   - Mono 1 Cut Pure
   - Mono 1 Coag Spray
5. LigaSure 1 current. Connect a 200 Ω load from the left LigaSure 1 output through the current transformer to the right LigaSure 1 output. Activate the following modes one at a time.
   - Mono 1 Cut Pure
   - Mono 1 Coag Spray
6. LigaSure 2 current. Connect a 200 Ω load from the left LigaSure 2 output through the current transformer to the right LigaSure 2 output. Activate the following modes one at a time.
   - Mono 1 Cut Pure
   - Mono 1 Coag Spray

Confirming Power Delivery at Receptacle

Important

The output of any receptacle equipped with a barcode scanner may only be verified using an appropriate barcode or dot-code accessory.

The system must be in the Demo mode to confirm outputs.

The ForceTriad is designed to function only as a Return Electrode Contact Quality Monitor (RECQM) equipped unit. For instructions to disable the RECQM circuit, see *Enable Demo Mode* on page 6-15.

Checking Bipolar Footswitch Activation

1. Verify that the system successfully completes the self-test as described in *Testing the System* on page 6-15.
2. Connect the test equipment for bipolar output:
   - **a.** Connect the two test cables from the Bipolar-Instrument-receptacle jacks routing one cable through a current transformer, and both test cables into a 100 Ω load. Ensure the test cables depress both the sensing switches of the receptacle.
   - **b.** Connect the bipolar footswitch to the Bipolar Footswitch receptacle on the rear panel.
   - **c.** Connect the bipolar footswitch to the Bipolar Footswitch receptacle on the rear panel.
3. Press the **Low** button and set the bipolar power to 95 W.
4. Test the output for the selected Bipolar mode:
   - **a.** Press the footswitch pedal and, while activating the system, note the output on the voltmeter.
   - **b.** Release the footswitch pedal.
5. Verify that the system output for standard and macro mode is between 900 mA and 1044 mA RMS.

   If the output is outside the specified range, calibrate the voltage and current as described in calibration steps 7 and 8 starting on page 6-8 then repeat this procedure. If the output remains outside the specified range, contact Covidien Technical Service (see page 9-4).

Checking the Monopolar 1 and Monopolar 2 Output for Cut Modes

1. Verify that the system successfully completes the self-test as described in *Testing the System* on page 6-15.
2. Connect the test equipment for monopolar output.
   a. Connect a handswitching test cable to the Monopolar 1 Instrument receptacle.
   b. Connect the REM plug to the REM jack shorting the two patient-return-electrode pins together.
   c. Connect a test cable from the patient-return-electrode jack through a current transformer and onto a 300 Ω load.
   d. To complete the test circuit connect the opposite end of the 300 Ω load to the end of the handswitching test cable.
3. Press the **Pure** button on the Monopolar 1 screen.
4. Press the **Cut** up-arrow button to set the cut power to 300 W.
5. Test the monopolar cut output.
   a. Press the handswitch cut button and, while activating the system, note the output on the voltmeter.
   b. Verify that the system output is between 922 mA and 1072 mA RMS.
   c. Release the handswitch button.

   If the output is outside the specified range, calibrate the voltage and current as described in calibration steps 7 and 8 on page 6-8 then repeat this procedure. If the output for one or more cut modes remains outside the specified range, contact Covidien Technical Service (see page 9-4).
6. Repeat steps 2 through 5 for Monopolar 2 output.

Check the Monopolar 1 and Monopolar 2 Output for Coag Modes

1. Verify that the system successfully completes the self-test as described in *Testing the System* on page 6-15.
2. Connect the test equipment for monopolar output.
   a. Connect a handswitching test cable to the Monopolar 1 Instrument receptacle.
   b. Connect the REM plug to the REM jack shorting the two patient-return-electrode pins together.
   c. Connect a test cable from the patient-return-electrode jack through a current transformer and onto a 500 Ω load.
   d. To complete the test circuit connect the opposite end of the 500 Ω load to the end of the handswitching test cable.
3. Press the **Spray** button on the Monopolar 1 screen.
4. Press the **Coag** up- or down-arrow buttons to set the coag power to 120 W.

5. Test the monopolar coag output.

   a. Press the handswitch coag button and, while activating the system, note the output on the voltmeter.

   b. Verify that the system output is between 452 mA and 525 mA RMS.

   c. Release the handswitch button.

   If the output is outside the specified range, calibrate the voltage and current as described in calibration steps 7 and 8 on page 6-8, then repeat this procedure. If the output for one or more coag modes remains outside the specified range, contact Covidien Technical Service (see page 9-4).

6. Repeat steps 2 through 5 for Monopolar 2 output.

Checking the UFP Output for Cut and Coag Modes

1. Verify the system successfully completes the self-test as described in *Testing the System* on page 6-15.
2. Connect the test equipment for UFP cut output.

   a. Connect a handswitching test cable to the Monopolar 1 Instrument receptacle.

   b. Connect the REM plug to the REM jack shorting the two patient-return-electrode pins together.

   c. Connect a test cable from the patient-return-electrode jack through a current transformer and onto a 300 Ω load.

   d. To complete the test circuit connect the opposite end of the 300 Ω load to the end of the handswitching test cable.

3. Press the Cut up-arrow button to set the cut power to 300 W.
4. Test the monopolar cut output.

   a. Press the **Cut** button, and while activating the system note the output on the voltmeter.

   b. Verify the system output is between 922 mA and 1072 mA RMS.

   c. Release the footswitch button.

5. Remove the 300 Ω resistor and replace it with a 500 Ω resistor.
6. Press the Coag up-arrow button to set the coag power to 120 W.
7. Test the monopolar coag output.

   a. Press the **Coag** button, and while activating the system note the output on the voltmeter.

   b. Verify that the system output is between 452 mA and 525 mA RMS.

   c. Release the footswitch button.

If the output is outside the specified range, calibrate the voltage and current as described in calibration steps 7 and 8 on page 6-8, then repeat this procedure. If the output for one or more modes remains outside the specified range, contact Covidien Technical Service (see page 9-4).

Checking the Monopolar 1 and Monopolar 2 Output for Valleylab Mode (Force TriVerse)

Notice

This testing requires a TriVerse 3-button pencil. Do not do this test step if the required equipment is not available.

1. Verify the system successfully completes the self-test as described in *Testing the System* on page 6-15.
2. Connect the test equipment for monopolar output.
   - **a.** Connect a Force TriVerse instrument in the Monopolar 1 instrument receptacle.
   - **b.** Connect a REM plug to the REM jack.
   - **c.** Connect a test cable from the Patient Return Electrode receptacle through a current transformer and into a 300 Ω resistor.
   - **d.** Connect a second test cable from the Force TriVerse pencil into the 300 Ω resistor.
3. Press the Cut up-arrow button to set the cut power to maximum output.
4. Test the monopolar cut and VL mode outputs.
   - **a.** Press the Force TriVerse **Cut** button and while activating the system, note the output on the voltmeter.
   - **b.** Verify the system output is between 922 mA and 1072 mA RMS.
   - **c.** Release the **Cut** button.
   - **d.** Press the Force TriVerse **V** button and while activating the system, note the output on the voltmeter.
   - **e.** Verify the system output is between 753 mA and 876 mA RMS.
   - **f.** Release the **V** button.
5. Remove the 300 Ω resistor and replace it with a 500 Ω resistor.
6. Press the **Coag up-arrow** button to set the coag power to maximum output.
7. Test the monopolar coag output.
   - **a.** Press the Force TriVerse **Coag** button and while activating the system, note the output on the voltmeter.
   - **b.** Verify the system output is between 452 mA and 525 mA RMS.
   - **c.** Release the **Coag** button.

If the output is outside the specified range, calibrate the voltage and current as described in calibration steps 7 and 8 on page 6-8, then repeat this procedure. If the output for one or more modes remains outside the specified range, contact Covidien Technical Service (see page 9-4).

Verifying Power Output

Equipment required:

- Test cable leads
- UFP adaptor

For each of the power output tests:

- Enter Demo or Debug mode as described *Enable Demo Mode* on page 6-15 or *Entering Debug Mode* on page 6-16.
- Test all power output modes with the loads specified in the following tables.

Testing Bipolar Output - 100 Ω

10 W	Low	291 mA - 339 mA
	Standard	291 mA - 339 mA
	Macro	291 mA - 339 mA
30 W	Low	504 mA - 587 mA
	Standard	504 mA - 587 mA
	Macro	504 mA - 587 mA
95 W	Low	900 mA - 1044 mA
	Standard	900 mA - 1044 mA
	Macro	900 mA - 1044 mA

1. Activate the bipolar FTSW and measure between the two bipolar jacks using a 100 Ω load.
2. Verify that the power outputs are within the specified range for each output mode.

Testing Cut Output - 300 Ω

10 W	Pure	146 mA - 218 mA
	Blend	146 mA - 218 mA
75 W	Pure	461 mA - 536 mA
	Blend	461 mA - 536 mA
300 W	Pure	922 mA - 1072 mA
200 W	Blend	753 mA - 876 mA

1. Activate the monopolar FTSW and measure between the UFP jack and the REM jack using a 300 Ω load.
2. Verify that the power outputs are within the specified range for each output mode.

Testing Valleylab Mode Output - 300 Ω

10 W	VL Mode	146 mA - 218 mA
75 W	VL Mode	461 mA - 536 mA
200 W	VL Mode	753 mA - 876 mA

A 3-button pencil (Force TriVerse) is required to perform this test.

1. Activate the 3-button pencil in Monopolar 1 and measure between the 3-button pencil and the REM jack using a 300 Ω load.
2. Verify that the power outputs are within the specified range for each output mode.

Testing Coag Output - 500 Ω

1 W	Fulgurate	20 mA - 100 mA
	Spray	20 mA - 100 mA
30 W	Fulgurate	226 mA - 263 mA
	Spray	226 mA - 263 mA
120 W	Fulgurate	452 mA - 525 mA
	Spray	452 mA - 525 mA

1. Activate the Monopolar FTSW and measure between the UPF jack and the REM jack using a 500 Ω load.
2. Verify that the power outputs are within the specified range for each output mode.

Testing LigaSure Output - 50 Ω

LigaSure 1 and LigaSure 2	1 A	288 mA - 355 mA
	2.7 A	761 mA - 885 mA
	5.5 A	1540 mA - 1790 mA

Notice

The system must be in Debug mode for this test. See *Entering Debug Mode* on page 6-16 for proper screen setup.

1. The Debug screen should display the following selections:

- Mode Selection – LigaSure Test
- Port Selection – LigaSure 1 Port
- Level – 1, 2.7, and 5.5 for each test

2. Activate by selecting the **RF ON** button and measure between the two LigaSure jacks using a 50 Ω load.
3. Press **RF OFF** button to stop the flow of RF to the port.
4. Verify that the power outputs are within the specified range for each output mode.
5. Repeat steps 1 through 4 using LigaSure 2 Port as the input for Port Selection in the Debug screen.

Checking High-Frequency Leakage Current

Check the high-frequency leakage current and ground resistance before returning the ForceTriad to clinical use. Check the leakage current:

- After calibrating the system
- Annually

Equipment required:

- 200 Ω, 250 W, noninductive resistor
- Current transformer
- True RMS voltmeter (Fluke 8920, BC Group ESU-2050, or equivalent)
- Bipolar and monopolar footswitches
- Leakage table - in accordance with IEC 601-2-2, Figure 104

Checking Monopolar High-Frequency Leakage Current

Notice

The system must be in Debug mode to activate the port. See *Entering Debug Mode* on page 6-16 for proper screen setup.

Hand and foot switches should not be used for this portion of testing.

1. Connect the 200 Ω load from the UFP to the true RMS voltmeter or equivalent to the equipotential ground lug on the rear of the system.
2. Manually activate the monopolar port using the debug screen at the maximum control setting. Record the leakage current. If using the leakage table, leakage current should not exceed 100 mA for any mode.
3. If the high-frequency leakage exceeds 100 mA, perform a power calibration. If the measurements still exceed 100 mA, contact Covidien Technical Service (see page 9-4) for further instructions.
4. Repeat steps 1 through 3 for monopolar 1 and monopolar 2 using the left tine for each receptacle.

Checking Bipolar High-Frequency Leakage Current

1. Remove the monopolar accessories and connect the 200 Ω load from the left tine of the bipolar output to the true RMS voltmeter or equivalent to the equipotential ground lug on the rear of the system.
2. Manually activate the Bipolar port using the Debug screen at the maximum control setting. Record the leakage current. It should not exceed 69 mA for any mode using either the leakage table or short lead configuration.
3. Repeat steps 1 through 2 for the right tine.

4. If the high-frequency leakage exceeds 69 mA, perform a power calibration. If the measurements still exceed 69 mA, contact Covidien Technical Service (see page 9-4) for further instructions.

Checking LigaSure High-Frequency Leakage Current

Notice

The system must be in Debug mode with Mode Selection set to LigaSure Test, and the port set to LigaSure 1 Port. See *Entering Debug Mode* on page 6-16 for proper screen setup.

1. Connect the 200 Ω load from the left tine of the LigaSure receptacle to the true RMS voltmeter or equivalent to the equipotential ground lug on the rear of the system.
2. In Debug mode, set the Level to maximum output and press the **Start RF** button. Record the leakage current. The leakage current should not exceed 130 mA for any mode.
3. Repeat steps 1 to 3 for the right tine.
4. Repeat this testing process for both tines of the LigaSure 2 port.
5. If the high-frequency leakage exceeds 130 mA, perform a power calibration. If the measurements still exceed 130 mA, contact Covidien Technical Service (see page 9-4).

Checking Patient High-Frequency Leakage

Notice

The system must be in Debug mode with Mode Selection set to Mono Cut and the port set to Mono2 Port. See *Entering Debug Mode* on page 6-16 for proper screen setup.

1. Connect the 200 Ω load from the patient-return port to the true RMS voltmeter or equivalent to the equipotential ground lug on the rear of the unit.
2. Manually activate the monopolar port 2 using the Debug screen at the maximum setting in Cut, Blend, HWD, Fulgurate, and Spray.
3. If the patient high-frequency leakage exceeds 100 mA, perform a power calibration. If the measurements still exceed 100 mA, contact Covidien Technical Service (see page 9-4).

Safety Testing in Accordance with IEC601

Equipment required:

- Safety tester

Replace the cover on the system using the four mounting screws to secure it.

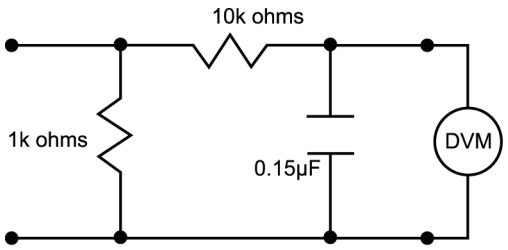
Note: Low-frequency tests are conducted at 10% above line voltage.

Checking Low-Frequency Leakage Current

Check the low-frequency leakage current before returning the ForceTriad to clinical use.

Equipment required:

- DVM
- Leakage current tester



1 millivolt = 1 microamp

Leakage current test circuit regarding IEC 60601-1

Chassis or Earth Leakage

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the system.
3. Measure between the chassis and earth ground.
4. Determine the leakage current using the conventional 1 mA for each 1 mV.
5. Verify under normal conditions (ground closed, normal polarity) the leakage current is less than 300 mA. If the leakage current is greater than 300 mA, contact Covidien Technical Service (see page 9-4).
6. Verify single fault conditions (open neutral) the leakage current is less than or equal to 1000 mA. If the leakage current is greater than 1000 mA, contact Covidien Technical Service (see page 9-4).

Output Receptacles and REM Source Current

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the system.
3. Measure between all the output receptacles (including the Patient Return Electrode receptacle) and earth ground. Record the largest reading.
4. Determine the leakage current using the conventional 1 mA for each 1 mV.

5. Verify under normal conditions (ground closed, normal polarity) the leakage current is less than 10 mA. If the leakage current is greater than 10 mA, contact Covidien Technical Service (see page 9-4).
6. Verify single fault conditions (ground open) the leakage current is less than or equal to 50 mA. If the leakage current is greater than 50 mA, contact Covidien Technical Service (see page 9-4).

Output Receptacles and REM Sink Current

1. Set the DVM to AC volts (200 mV) and connect the leakage current test circuit.
2. Turn on the system and connect the end of the leakage current test circuit to mains voltage through a 120 Ω, ¾ W resistor.
3. Connect the other side of the IEC leakage load to all of the output receptacles (including the Patient Return Electrode receptacle)
4. Determine the leakage current using the conventional 1 µA for each 1 mV.
5. Verify the leakage current is less than or equal to 50 mA. If the leakage current is greater than 50 mA, contact Covidien Technical Service (see page 9-4).

Ground Bond Testing

1. Connect the system to a ground bond tester.
2. Test between the equipotential ground lug on the rear of the system and the supplied Covidien power cord, or directly to the middle ground pin of the inlet receptacle.
3. Initiate the test according to IEC standards.
4. Specifications are 0.2 ohms using a Covidien-supplied power cord or 0.1 ohm connected directly to the middle pin of the inlet receptacle. If the specifications are not met during the ground bond testing, contact Covidien Technical Service (see page 9-4).

Docking to Valleylab Exchange

Equipment required:

- RS-232 cables
- Valleylab Exchange software
- *ForceTriad User's Guide*

1. After completing service or preventive maintenance, the system should be docked to Valleylab Exchange to log any changes to the system in the master directory.
2. The *ForceTriad Energy Platform User's Guide* contains instructions for docking to Valleylab Exchange. Follow the steps outlined in the guide for loading Valleylab Exchange software and docking the system to the Valleylab Exchange.

Preventive Maintenance Check Sheet

Unit Serial Number Date of Maintenance

Initial Inspection

Rear panel inspection	Accept Y or N
Front panel inspection	Accept Y or N
Footswitch inspection	Accept Y or N
Power cord inspection	Accept Y or N
Internal component inspection	Accept Y or N

System Self-Check

System self-check	Accept Y or N

Calibration (if applicable)

Calibration Level	Complete

Low-Voltage Power Supply (if applicable)

+ 5 VDC	5.00 V to 5.20 V
+12 VDC	11.4 V to 13.2 V
-12 VDC	-12.36 V to -11.64 V

Audio

Tone audible at high and low ranges	Accept Y or N

REM Function

Receive a green indicator at 120 Ω	Accept Y or N
Receive an audible tone at > 128 Ω and < 142 Ω	Accept Y or N
Receive a green indicator at 60 Ω	Accept Y or N
Receive an audible tone at > 77 Ω and < 91 Ω	Accept Y or N
Receive a green indicator at 30 Ω	Accept Y or N
Receive a green indicator at 10 Ω	Accept Y or N
Receive a red indicator before 1 Ω	Accept Y or N

Autobipolar Tests

RF generation at 20 W when 45 Ω is connected	Accept Y or N
RF generation stops when disconnected	Accept Y or N
RF generation at 20 W when 940 Ω is connected	Accept Y or N
RF generation stops when disconnected	Accept Y or N
RF generation at 20 W when 1070 Ω is connected	Accept Y or N
RF generation does not occur when input is shorted together	Accept Y or N

Cross Coupling

Monopolar 1	Mono 2 Cut	0 mA - 140 mA
	Mono 2 Spray	0 mA - 140 mA
UFP	Mono 2 Cut	0 mA - 140 mA
	Mono 2 Spray	0 mA - 140 mA
Monopolar 2	Mono 1 Cut	0 mA - 140 mA
	Mono 1 Spray	0 mA - 140 mA
Bipolar	Mono 1 Cut	0 mA - 140 mA
	Mono 1 Spray	0 mA - 140 mA
LigaSure 1	Mono 1 Cut	0 mA - 140 mA
	Mono 1 Spray	0 mA - 140 mA
LigaSure 2	Mono 1 Cut	0 mA - 140 mA
	Mono 1 Spray	0 mA - 140 mA

Power Delivery at Receptacle

Bipolar (Bipolar FTSW)	100 Ω Low	900 mA - 1044 mA
	100 Ω Standard	900 mA - 1044 mA
	100 Ω Macro	900 mA - 1044 mA
Monopolar 1 (2-button HDSW)	300 Ω Cut Pure	922 mA - 1072 mA
	500 Ω Coag Spray	452 mA - 525 mA
Monopolar 2 (2-button HDSW)	300 Ω Cut Pure	922 mA - 1072 mA
	500 Ω Coag Spray	452 mA - 525 mA
UFP (Monopolar FTSW)	300 Ω Cut Pure	922 mA - 1072 mA
	500 Ω Coag Spray	452 mA - 525 mA
Monopolar 1 (Force TriVerse)	300 Ω Cut	922 mA - 1072 mA
	300 Ω VL Mode	753 mA - 876 mA
	500 Ω Coag	452 mA - 525 mA
Monopolar 2 (Force TriVerse)	300 Ω Cut	922 mA - 1072 mA
	300 Ω VL Mode	753 mA - 876 mA
	500 Ω Coag	452 mA - 525 mA

Power Output

Bipolar Output - 100 Ω

10 W	Low	291 mA - 339 mA
	Standard	291 mA - 339 mA
	Macro	291 mA - 339 mA
30 W	Low	504 mA - 587 mA
	Standard	504 mA - 587 mA
	Macro	504 mA - 587 mA
95 W	Low	900 mA - 1044 mA
	Standard	900 mA - 1044 mA
	Macro	900 mA - 1044 mA

Testing Cut Output - 300 Ω

10 W	Pure	146 mA - 218 mA
	Blend	146 mA - 218 mA
75 W	Pure	461 mA - 536 mA
	Blend	461 mA - 536 mA
300 W	Pure	922 mA - 1072 mA
200 W	Blend	753 mA - 876 mA

Testing Valleylab Mode Output - 300 Ω

10 W	VL Mode	146 mA - 218 mA
75 W	VL Mode	461 mA - 536 mA
200 W	VL Mode	753 mA - 876 mA

Testing Coag Output - 500 Ω

1 W	Fulgurate	20 mA - 100 mA
	Spray	20 mA - 100 mA
30 W	Fulgurate	226 mA - 263 mA
	Spray	226 mA - 263 mA
120 W	Fulgurate	452 mA - 525 mA
	Spray	452 mA - 525 mA

Testing LigaSure Output - 50 Ω

			LigaSure 1	LigaSure 2
LigaSure	1 A	288 mA - 355 mA		
	2.7 A	761 mA - 885 mA		
	5.5 A	1540 mA - 1790 mA		

High-Frequency Leakage

UFP Leakage	Cut Pure	0 mA - 100 mA
	Cut Blend	0 mA - 100 mA
	HWD	0 mA - 100 mA
	Coag Fulgurate	0 mA - 100 mA
	Coag Spray	0 mA - 100 mA
Monopolar 1 Leakage	Cut Pure	0 mA - 100 mA
	Cut Blend	0 mA - 100 mA
	HWD	0 mA - 100 mA
	Coag Fulgurate	0 mA - 100 mA
	Coag Spray	0 mA - 100 mA
Monopolar 2 Leakage	Cut Pure	0 mA - 100 mA
	Cut Blend	0 mA - 100 mA
	HWD	0 mA - 100 mA
	Coag Fulgurate	0 mA - 100 mA
	Coag Spray	0 mA - 100 mA
Bipolar Leakage	Bipolar Standard (Left Tine)	0 mA - 69 mA
	Bipolar Macro (Left Tine)	0 mA - 69 mA
	Bipolar Low (Left Tine)	0 mA - 69 mA
	Bipolar Standard (Right Tine)	0 mA - 69 mA
	Bipolar Macro (Right Tine)	0 mA - 69 mA
	Bipolar Low (Right Tine)	0 mA - 69 mA

Continued

LigaSure 1 Leakage	LigaSure (Left Tine)	0 mA - 130 mA
	LigaSure (Right Tine)	0 mA - 130 mA
LigaSure 2 Leakage	LigaSure (Left Tine)	0 mA - 130 mA
	LigaSure (Right Tine)	0 mA - 130 mA
Patient Return Leakage	Cut Pure	0 mA - 100 mA
	Cut Blend	0 mA - 100 mA
	HWD	0 mA - 100 mA
	Coag Fulgurate	0 mA - 100 mA
	Coag Spray	0 mA - 100 mA

Safety Test in Accordance with IEC601

Earth Leakage	Normal Conditions	0 mA - 300 mA
	Open Neutral	0 mA - 1000 mA
Patient Leakage	Normal Conditions	0 mA - 10 mA
	Open Ground	0 mA - 50 mA
Sink Current (Mains to Applied Parts)	Normal Conditions	0 mA - 10 mA
	Open Ground	0 mA - 50 mA
Ground Bond Test		Accept Y, N, or N/A

Valleylab Exchange

Unit Docked to Valleylab Exchange	Accept Y, N, or N/A

Chapter 7

Troubleshooting

If the system is not functioning properly, use the information in this chapter to perform the following tasks:

- Identify and correct the malfunction
- If a system error was displayed, take the appropriate action to correct the condition.

Additional technical information may be available through Covidien Technical Service (see page 9-4).

Inspecting the ForceTriad Energy Platform

If the system malfunctions, check for obvious conditions that may have caused the problem:

- Check the system for visible signs of physical damage.
- Verify that all accessory cords are properly connected.
- Check the power cord for exposed wires, cracks, frayed insulation, or a damaged connector. Replace damaged cords.
- Open the fuse drawer and inspect the fuse housing and fuses for damage and corrosion. Verify that the fuses are firmly seated.

An internal component malfunction in the system can damage the fuses. Fuse replacement may be necessary if the system fails the self-test or stops functioning.

Responding to System Errors

Example

- *E277* is the error identification number.
- *SELF_TESTS* identifies the file name within the code where the error occurred.
- *H* identifies the processor in which the error occurred.
  (H = Host, 1 = Main Digital Signal Processor, 2 = Backup Digital Signal Processor)
- *0.0014* identifies the version of code.
- *L1603* identifies the line of code at which the error occurred.

Important

When contacting Covidien Service, include all screen information.

System-Error Descriptions

When system errors occur, the system is no longer functional. Recycling power may clear the system error.

Non-Recoverable Error Descriptions

When non-recoverable errors occur, the system has limited functionality, but does not allow RF output. The system allows qualified service personnel to access the diagnostic service menu to aid in troubleshooting the unit. Software downloads can be performed and some limited capability is permitted within the main menus.

When the Diagnostic menu is selected, the user can choose to disable errors. When errors are disabled, the user has access to the full capability of the system and further non-recoverable errors do not limit this capability. However, because errors have occurred, the system may not function to specifications. The user can only enable errors by recycling power.

Some system and non-recoverable errors are corrected automatically by cycling power; however, most require some action by the user to correct the condition. When an error occurs, record all screen information then cycle (turn off, then turn on) the system. After correcting an error condition, verify the system completes the self-test. If the error persists, use the troubleshooting guide in this section to further analyze the issue. Should you be unable to correct the issue after using the troubleshooting guide, contact Covidien Technical Service (see page 9-4).

E2 ERR_SE_ICL_ERROR

Unable to communicate to hardware using the Host ICL registers.

E3 ERR_SE_APP_ROM_FAIL

DSP application ROM check failed at startup.

E4 ERR_SE_BOOT_ROM_FAIL

DSP boot ROM check failed at startup.

E5 ERR_SE_RAM_FAIL

DSP RAM check failed at startup.

For E2, E3, E4, and E5 perform the following steps:

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.

5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E6 ERR_SE_RTOS_FAIL

Software error - A real time operations system failure.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If replacing the controller board does not correct the error, replace the display and perform a level-3 calibration.
6. If the new board and new display does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E7 ERR_SE_GEN_FAIL

General system-error failure.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E8 ERR_SE_CRITICAL_DATA

Software error - Critical data has been corrupted.

E9 ERR_SE_ASSERT

Software error - A software failure has occurred that has generated an assertion.

E10 ERR_SE_INVALID_DATA

Software error - A software failure has occurred because of invalid data.

For E8, E9, and E10 perform the following steps:

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E11 ERR_SE_MACHINE_CHECK_EXCEPTION

A host processor machine check exception has occurred.

E12 ERR_SE_DATA_STORAGE_EXCEPTION

A host processor data storage exception has occurred.

E13 ERR_SE_ISI_EXCEPTION

A host processor information exception has occurred.

E14 ERR_SE_ALIGNMENT_EXCEPTION

A host processor alignment exception has occurred.

E15 ERR_SE_PROGRAM_EXCEPTION

A host processor program exception has occurred.

E16 ERR_SE_FP_UNAVAILABLE_EXCEPTION

A host processor floating point unavailable exception has occurred.

E17 ERR_SE_SYS_CALL_EXCEPTION

A host processor system call exception has occurred.

E18 ERR_SE_TRACE_EXCEPTION

A host processor trace exception has occurred.

E19 ERR_SE_FP_ASSIST_EXCEPTION

A host processor floating point assist exception has occurred.

E20 ERR_SE_MEM_ALLOC_EXCEPTION

A memory allocation failure has occurred.

E21 ERR_SE_UNKNOWN_EXCEPTION

A host processor has generated an unknown exception. The exception vector is not a valid vector.

E22 ERR_SE_UNKNOWN_INTERRUPT

A host processor has received an interrupt that is not initialized.

E23 ERR_SE_STACK_OVERFLOW

A tread on the host has overflowed its stack.

E24 ERR_SE_DMA_FAILURE

The iDMA is stuck.

E25 ERR_SE_UNHANDLED_INTERRUPT

A host processor has received an interrupt but does not know how to handle it.

E26 ERR_SE_MAX_NUM_THREADS_REG

The host code has attempted to register more threads than what is allowed.

E27 ERR_SE_NULL_POINTER

The host code has detected a pointer that has a NULL value.

For E11 through E27 perform the following steps:

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E257 ERR_NR_DOSAGE

General RF dosage error

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.

5. If the controller board replacement does not correct the error, replace the RF board and perform a level-5 calibration.
6. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E258 ERR_NR_MEM_ALLOC_FAIL

Software error - Memory allocation failure

E259 ERR_NR_INVALID_DATA

Software error - Invalid data

For E258, and E259 perform the following steps:

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E260 ERR_NR_COM_ERROR

Various communication errors

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Verify that the ribbon cables and FTSW cable connections are securely seated.
3. Cycle power to the unit. Allow the unit to go through its self-check.
4. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E261 ERR_NR_HW_ERROR

Hardware setup/control error

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the HVDC board and perform a level-4 calibration.
5. If replacing the HVDC board does not correct the error, replace the LVPS and perform a level 0 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E262 ERR_NR_ACT_DENIED

Activation denied error

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If the recalibration does not work, open the cover to the unit and inspect the RF board. Verify that the board is securely seated and fastened as expected. Verify that the cables are connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the RF board and perform a level-5 calibration.
5. If the RF board replacement does not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E263 ERR_NR_INVALID-STATE

Software error - Invalid state

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E264 ERR_NR_UNSUPPORTED _CMD

Software error - Unsupported command

E265 ERR_NR_ACCESS _FUNCTION

Software error - Access function error

For E264 and E265 perform the following steps:

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E266 ERR_NR_TIMEOUT_ERROR

A timeout occurred

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Verify that the ribbon cables and FTSW cable connections are securely seated.
4. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E267 ERR_NR_GEN_ERROR

General NR failure source unknown top level reporting.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E268 ERR_NR_SELF_TEST_ERROR

Self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E269 ERR_NR_DISPLAY_ERROR

Display error detected during host POST test.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the display and cables. Verify that the display cables are securely fastened as expected.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the display cables and perform a level-3 calibration.
5. If replacing the display cables does not correct the error, replace the display and perform a level-3 calibration.
6. If replacing the display does not correct the error, replace the controller board and perform a level-6 calibration.
7. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E270 ERR_NR_AUDIBLE_ERROR

Audio self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the FTSW board. Verify that all cables are securely fastened as expected.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the FTSW board and perform a level-2 calibration.
5. If replacing the FTSW board does not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E271 ERR_NR_STUCK_BUTTON_ERROR

Stuck button self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Ensure that the footswitch and hand pieces connected to the unit are not engaged.
3. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is securely fastened as expected.
5. Verify that the ribbon cables and FTSW cable connections are securely seated.
6. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
7. If replacing the controller board does not correct the error, replace the display and perform a level-3 calibration.
8. If the unit still displays the error and/or the recalibration does not correct the issue, replace the FTSW board and perform a level-2 calibration.
9. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E273 ERR_NR_INTER_PROC_COM_ERROR

Inter-processor communication self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is securely fastened as expected.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E274 ERR_NR_CRITICAL_DATA_ERROR

Critical data self-test error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. Verify that the ribbon cables and FTSW cable connections are securely seated.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the system scanners and perform a level-1 calibration.
6. If replacing the system scanners does not correct the issue, replace the controller board and perform a level-6 calibration.
7. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E275 ERR_NR_MULTI_TASKING_ERROR

Multi-tasking self-test error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. Verify that the ribbon cables and FTSW cable connections are securely seated.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E276 ERR_NR_ANALOG_SENSOR_ERROR

Analog sensor self-test error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the connection cables are connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the RF board and perform a level-5 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E277 ERR_NR_RF_SHUT_DWN_1_ERROR

RF generator shutdown self-test #1 error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the HVDC board and perform a level-4 calibration.
5. If replacing the HVDC board does not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new components do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E278 ERR_NR_RF_SHUT_DWN_2_ERROR

RF generator shutdown self-test #2 error.

1. Open the cover to the unit and inspect the RF board. Verify that the board is securely seated and fastened as expected. Verify that the connection cables are connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. If the unit still displays the error, replace the RF board and perform a level-5 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E279 ERR_NR_RF_SHUT_DWN_3_ERROR

RF generator shutdown self-test #3 error.

1. Open the cover to the unit and inspect the RF board. Verify that the board is securely seated and fastened as expected. Verify that the connection cables are connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. If the unit still displays the error, replace the RF board and perform a level-5 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E280 ERR_NR_TIMEBASE_ERROR

Time base comparison self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E281 ERR_NR_SYS_WATCH_DOG_ERROR

System watch dog self-test error.

1. Verify that no cables have been disconnected and that all internal cables are installed as expected.
2. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
3. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E282 ERR_NR_ICL_PROG_ERROR

ICL chip programmed self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E283 ERR_NR_RAM_MEMORY_ERROR

Ram memory self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E284 ERR_NR_FLASH_MEMORY_ERROR

FLASH memory self-test error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E285 ERR_NR_INVALID_CONFIG_DATA

Software error - configuration data is not valid (checksum error).

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E286 ERR_NR_NULL_PTR

Software error - null pointer detected.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E287 ERR_NR_AIE

Absolute integral error.

1. Using the data information found under Service -> Statistics -> Error List on the display panel of the unit, use table below to help isolate the error.

Data Code	Likely Issue
1 Voltage Issue	Controller Board
2 Current Issue	Controller Board
3 Power Average Issue	Controller Board
4 N/A	N/A
5 Leakage Issue	RF Board
6 Phase Issue	RF Board

2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. Cycle power to the unit. Allow the unit to go through its self-check.
4. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E288 ERR_NR_SENSOR_CLIP

DSP sensor clipping error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the HVDC board and perform a level-4 calibration.
5. If replacing the HVDC board does not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new components do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E289 ERR_NR_SENSOR_COMPARE

DSP sensor comparison error.

1. Using the data information found under Service -> Statistics -> Error List on the display panel of the unit, use table below to help isolate the error.

Data Code	Likely Issue
1 Voltage Issue	Controller Board
2 Current Issue	Controller Board
3 Power Average Issue	Controller Board
4 N/A	N/A
5 Leakage Issue	RF Board
6 Phase Issue	RF Board

2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. Cycle power to the unit. Allow the unit to go through its self-check.
4. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.

6. If replacing the controller board does not correct the error, replace the RF board and perform a level-5 calibration.
7. If replacing the RF board does not correct the error, replace the HVDC board and perform a level-4 calibration.
8. If the new components do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E290 ERR_NR_DATA SAMPLE_ERROR

VI data sampling error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E291 ERR_NR_COMM_WD_ERROR

Communication watchdog error.

1. Verify that no cables have been disconnected and that all internal cables are installed as expected.
1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E292 ERR_NR_DSP_SW_ERROR

Software error - generic DSP Software failure

1. Open the cover to the unit and inspect the HVDC board. Verify that the board is securely seated and fastened as expected. Verify that the cables are connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If replacing the controller board does not correct the error, replace the HVDC board and perform a level-4 calibration.
6. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E293 ERR_NR_FLASH_ERROR

Error occurred writing to FLASH

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E294 ERR_NR_OS_ERROR

Software error - real-time operating-system error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E295 ERR_NR_OS_ERROR

Error occurred storing data to NV store.

E296 ERR_NR_ICL_HB_ERROR

ICL heartbeat error.

E297 ERR_NR_MSG_VIEWER_CTOR_ERROR

Software error - message viewer class construction failure.

E298 ERR_NR_CTRL_REQ_ERROR

Software error - system controller unexpectedly denied request to bring up main menus.

For E295, E296, E297 and E298 perform the following steps:

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E299 ERR_NR_LKG_LIMIT

DSP2 leakage sensor compare error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the cables are connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the controller board and perform a level-6 calibration.
5. If the controller board replacement does not correct the error, replace the RF board and perform a level-5 calibration.
6. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E300 ERR_NR_BAD_SCANNER

Scanner failed self-test error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Clean the scan stand labels and surrounding area on the output port receptacles.
3. Clean the scanner glass above each of the scan stand labels.
4. Verify LED functionality for each port. If the LEDs are not functioning, replace the scanner. See *Barcode Scanner Replacement* on page 8-20.
5. Capture a scan stand image using the Main Menu -> Service -> Diagnostics -> Bar Code Image function. Verify that the scanner can see the scan stand. This picture should be clear and not dark.
6. Cycle power to the unit. Allow the unit to go through its self-check.
7. Perform a level-1 calibration of the system as described in *Calibration Levels* on page 6-6.
8. If the unit still displays the error and/or the recalibration does not correct the issue, replace the scanner and perform a level-1 calibration.
9. If replacing the scanner does not correct the error, replace the scanner cables and perform a level-1 calibration.
10. If the new components do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E301 ERR_NR_LOW_BATTERY

Battery self-test failure.

1. Open the cover to the unit and inspect the controller board and battery. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Attempt to cycle power to the unit. If the unit turns of, allow the unit to go through its self-check. If the error clears and the systems remains operable, the unit is ready for use.
3. If the unit still displays the error or will not turn on, replace the controller board and perform a level-6 calibration as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E302 ERR_NR_BIO_ERROR

Memory-mapped I/O error.

1. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the unit still displays the error or will not turn on, replace the controller board and perform a level-6 calibration.
5. If replacing the controller board does not correct the error, replace the LVPS and perform a level 0 calibration.
6. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E303 ERR_NR_DSP_VERIFY_ERROR

DSP configuration verify failure

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E304 ERR_NR_SCREEN_STACK_ERROR

Software error - error in screen stack manipulation in AppScreenBase.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.
3. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
4. If the unit still displays the error, replace the controller board and perform a level-6 calibration.
5. If replacing the controller board does not correct the error, replace the display and perform a level-3 calibration.
6. If the components and recalibration does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E305 ERR_NR_ROM_ERROR

ROM self-test failure.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E306 ERR_NR_NR_ICL_COMM_LINK_ERROR

ICL communication link test failure.

1. Open the cover to the unit and check the connections between the RF board and FTSW board. Check the ethernet cable connection between the controller board and the display board.
2. Cycle power to the unit. Allow the unit to go through its self-check.
3. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. Verify that the ribbon cables and FTSW cable connections are securely seated.
5. If the unit still displays the error and/or the recalibration does not correct the issue, replace the FTSW board and perform a level-2 calibration.
6. If replacing the FTSW board does not correct the error, replace the LVPS and perform a level 0 calibration.
7. If the unit still displays the error and/or the recalibration and the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E307 ERR_NR_RF_TEST4_ERROR

RF generator/shutdown self-test #4 Error.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
3. If recalibration does not work, open the cover to the unit and inspect the RF board. Verify that the board is securely seated and fastened as expected. Verify that the cables are connected to the system.
4. If the unit still displays the error and/or the recalibration does not correct the issue, replace the RF board and perform a level-5 calibration.
5. If replacing the RF board does not correct the error, replace the controller board and perform a level-6 calibration.
6. If replacing the controller board does not correct the error, replace the HVDC board and perform a level-4 calibration.
7. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E308 ERR_NR_UART_LOOP_BIT

The barcode reader uart has been changed and the loopback feature has been turned on. Any requests to the barcode reader will be sent back to the host rather than to the barcode reader.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, open the cover to the unit and inspect the scanner and scanner cables. Verify that the scanner and cables are securely seated and fastened as expected.
3. If the unit still displays the error, replace the scanner cables and perform a level-1 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If replacing the scanner and cables does not correct the error, replace the controller board and perform a level-6 calibration.
5. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E309 ERR_NR_RDM_INVALID_WINDOW

The remote control feature has been given an invalid window pointer.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, open the cover to the unit and inspect the displays and display cables. Ensure that the displays and cables are securely seated and fastened as expected.
3. If the unit still displays the error, replace the display cables and perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If replacing the display cables do not correct the error, replace the displays and perform a level-3 calibration.
5. If replacing the displays do not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E310 ERR_NR_RDM_INVALID_FIELD_LIST

The remote control feature has been given an invalid field list.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. If the error does not clear, open the cover to the unit and inspect the displays and display cables. Ensure that the displays and cables are securely seated and fastened as expected.
3. If the unit still displays the error, replace the display cables and perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If replacing the display cables do not correct the error, replace the displays and perform a level-3 calibration.
5. If replacing the displays do not correct the error, replace the controller board and perform a level-6 calibration.
6. If the new boards do not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

E311 ERR_NR_INVALID_RF_HDW_CONFIG

The host has an invalid combination of hardware versions.

1. Cycle power to the unit. Allow the unit to go through its self-check. If the error clears, the unit is ready for use.
2. Open the cover to the unit and inspect the controller board. Verify that the board is securely seated and fastened as expected. Verify that the ethernet cable is connected to the system.
3. If the unit still displays the error, replace the controller board and perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
4. If the new board does not correct the issue, contact your local Covidien Technical Service for further instructions (see page 9-4).

Chapter 8

Replacement Procedures

Follow the procedures in this chapter if replacement becomes necessary for the components listed below:

- Front-Panel Assembly
- System Fuses
- Battery
- Low-Voltage Power Supply
- Footswitch/Audio PCBA
- Controller PCBA
- High-Voltage DC PCBA
- Steering-Relay PCBA
- Display PCBA
- Barcode Scanner
- Output Receptacles
- Barcode-Scanner Cables
- System Displays
- System-Display Cables
- System Fans
- Scan-Stand Label

The parts used in these procedures are listed in Chapter 10, *Service Parts.*

Removing and Reinstalling the Front Panel

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

To service many of the components of the system, it is necessary to remove the front panel of the system. The steps listed here are referenced throughout the procedures for servicing other components.

Removing the Front Panel

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the three screws attaching the font-panel assembly to the top rail of the chassis. Remove the four screws at the sides of the front panel attaching it to the chassis.
4. Disconnect cable assemblies:
   a. Steering-Relay PCBA to RF PCBA
   b. Display PCBA to Controller PCBA
   c. Power switch to power receptacle
   d. Steering-Relay PCBA to HVDC PCBA
5. Rotate the top of the front-panel assembly downwards until the Steering-Relay PCBA clears the chassis top rail. Lift the front-panel assembly away from the chassis.

Complete the steps for replacing an internal component.

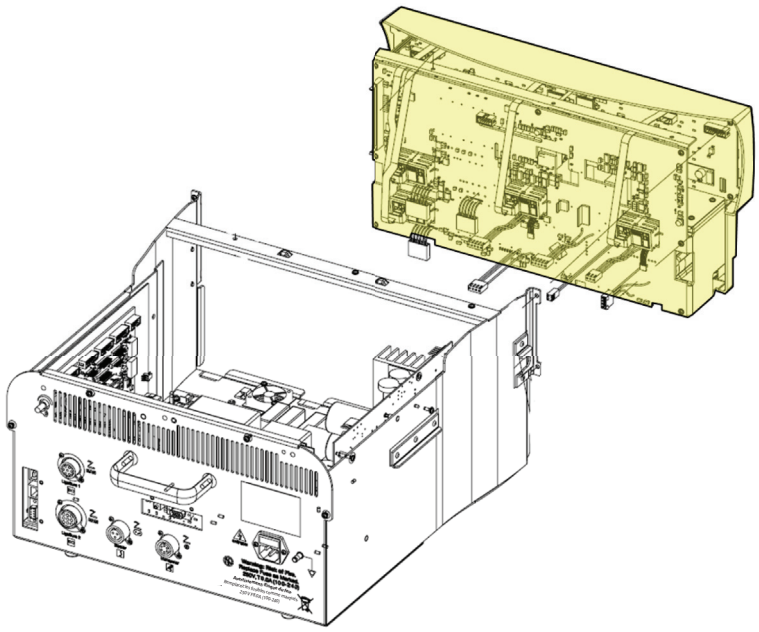
Reinstalling the Front Panel

1. Hold the assembly at an angle with the top away from the system.
2. Set the bottom of the front-panel assembly into the chassis, taking care to line up the alignment tabs.
3. Rotate the front-panel assembly towards the chassis, ensuring the fan cables are not pinched.
4. Slide the top of the Steering-Relay PCBA under the top rail of the chassis until the screw holes align.
5. Replace the three screws securing the front-panel assembly to the chassis top rail. Reinstall the four screws attaching the front panel to the chassis.
6. Reconnect cable assemblies:
   - **a.** Steering-Relay PCBA to RF PCBA
   - **b.** Display PCBA to Controller PCBA
   - **c.** Power switch to power receptacle
   - **d.** Steering-Relay PCBA to HVDC PCBA

Note: Reference *Block Diagram* on page 3-2 and the accompanying key on 3-3 for proper cable connections.

7. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
8. Recalibrate the system as described in *Calibration Levels* on page 6-6.

Front Panel.



Fuse Replacement

Equipment required:

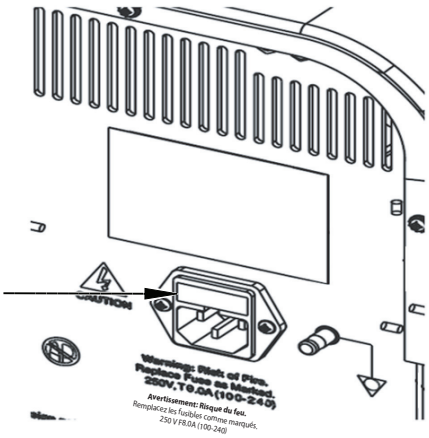
- Small flathead screwdriver

Warning

Fire Hazard For continued protection against fire hazard, replace fuses only with fuses of the same type and rating as the original fuse.

1. Turn off the system. Disconnect the power cord from the wall receptacle and the rear panel of the system for easier access to the adjacent fuse drawer.
2. To release the fuse drawer, insert a small flathead screwdriver into the slot on the drawer above the power cord receptacle, then slide the drawer out.
3. Replace each fuse with one of the same type and rating.
4. Slide the fuse drawer into its slot until it snaps into place.
5. Connect the power cord to the rear panel.

Fuse Drawer



Battery Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazards To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

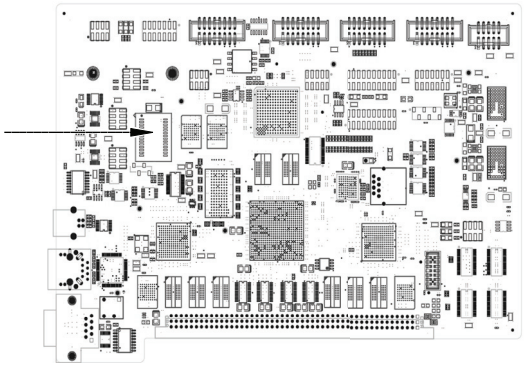
The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the system after every battery replacement. Calibration values are lost when the battery is replaced. Refer to *Calibrating the ForceTriad Energy Platform* on page 6-4 for instructions.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the battery on the left side of the Controller PCBA.
4. Grasp the battery and remove it from the socket.
5. Install the new battery.
6. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
7. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.

Battery Location on Controller Board



Low-Voltage Power Supply (LVPS) Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to re calibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the LVPS on the left rear of the unit and disconnect the cable assemblies from the LVPS.
4. Remove the three screws securing the LVPS to the chassis. Note that the lower-right screw is non-conductive nylon.

Note: Some system configurations are equipped with stand-off fasteners instead of screws. To remove the LVPS on these systems, disengage the stand-off by carefully pulling the LVPS away from the unit until the LVPS is free.

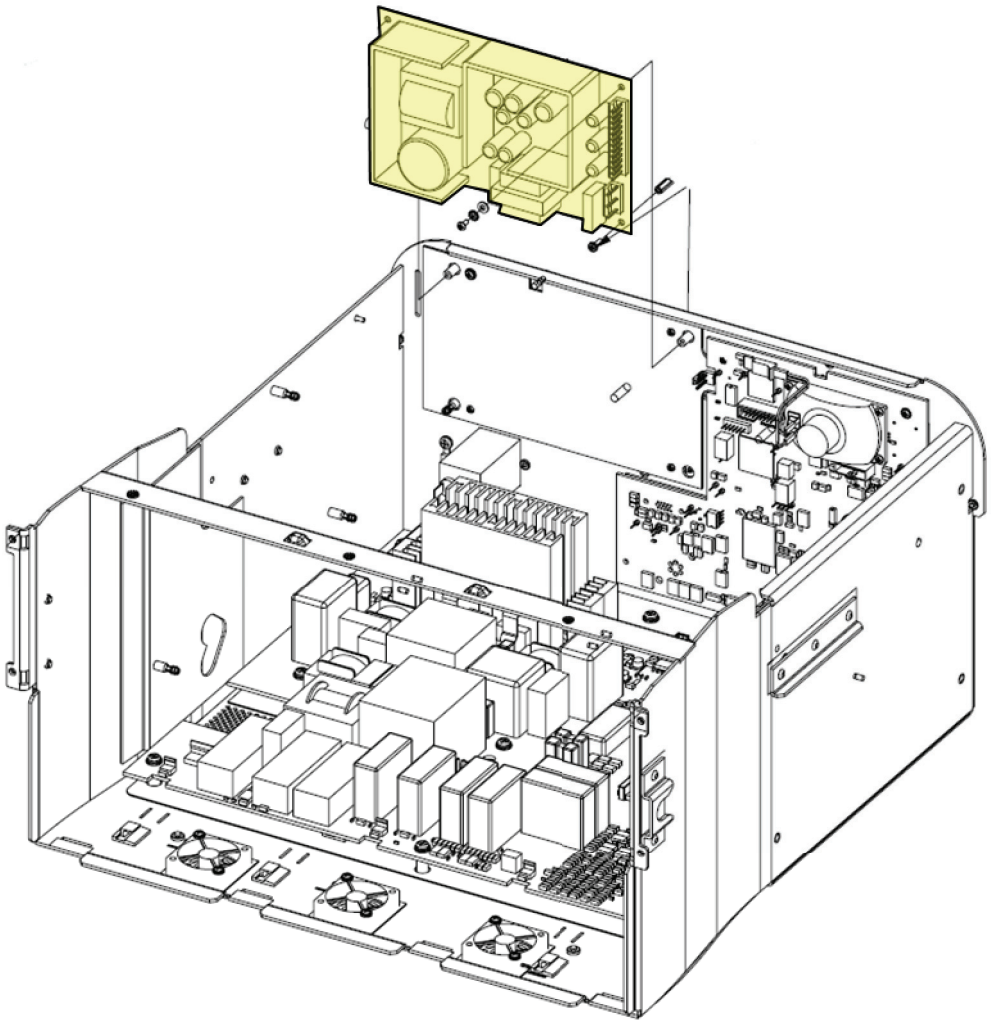
5. Remove the LVPS.
6. Install the new LVPS in the correct orientation.
7. Replace the three screws, ensuring the nylon screw is installed in the lower-right corner.

Note: Replacing the nylon screw with a metal screw may negatively affect system performance as well as overall system leakage. A metal screw may also cause the system to become inoperable due to the potential of system leakage.

8. Reconnect the cable assemblies.
9. Position the cover above the chassis and slide it down. Install the four screw that secure the cover to the chassis.

10. Perform a level-0 calibration of the system as described in *Calibration Levels* on page 6-6.

Low-Voltage Power Supply



Footswitch/Audio PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

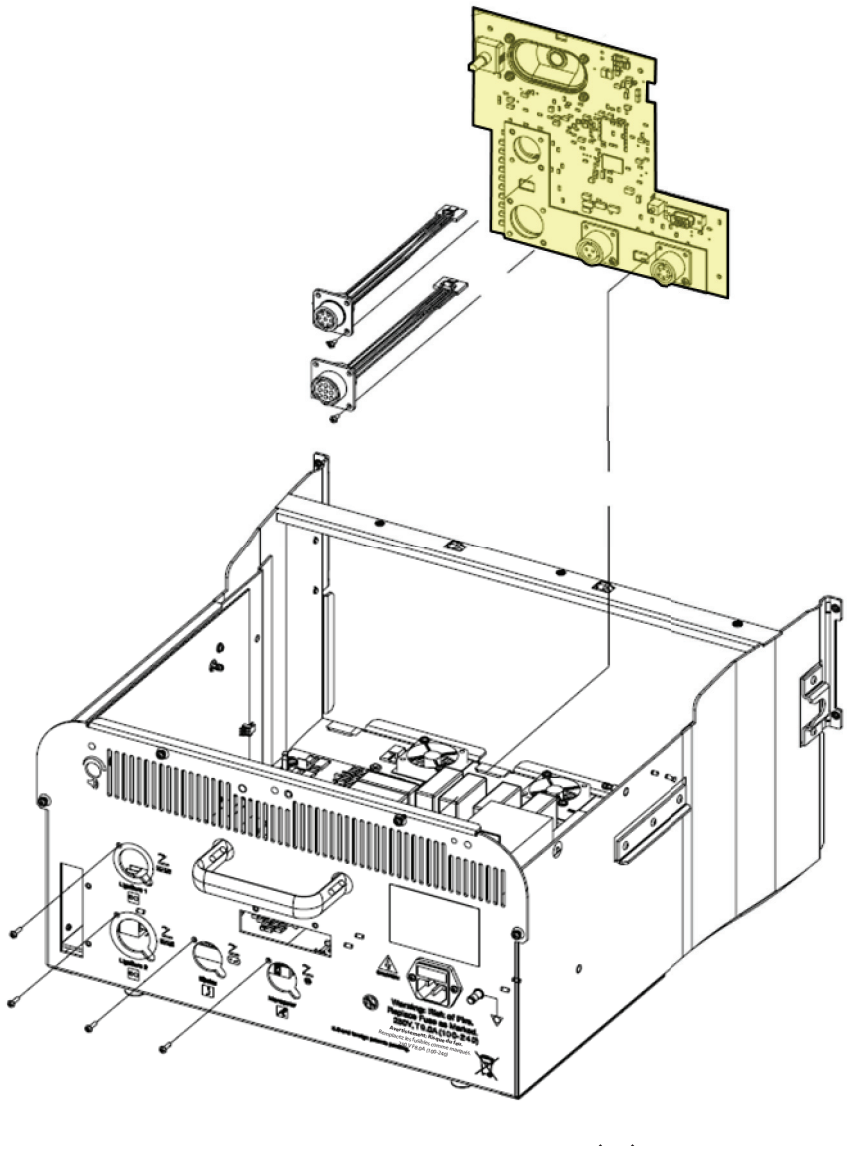
Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the Footswitch/Audio PCBA on the right rear of the system and disconnect the cable assemblies from the Footswitch/Audio PCBA.
4. Remove the two screws securing the Footswitch/Audio PCBA to the chassis. On the rear of the system, remove the four screws securing the Monopolar and Bipolar footswitch receptacles to the chassis.

Note: Some system configurations are equipped with stand-off fasteners instead of screws. To remove the FTSW on these systems, disengage the stand-off by carefully pulling the FTSW away from the unit until the LVPS is free.

5. Remove the Footswitch/Audio PCBA.
6. Install the new Footswitch/Audio PCBA.
7. Replace the two screws securing the Footswitch/Audio PCBA to the chassis. Replace the four screws securing the Monopolar and Bipolar footswitch receptacles to the chassis.
8. Reconnect the cable assemblies.
9. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
10. Perform a level-2 calibration of the system as described in *Calibration Levels* on page 6-6.

Footswitch/Audio PCBA



Controller PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

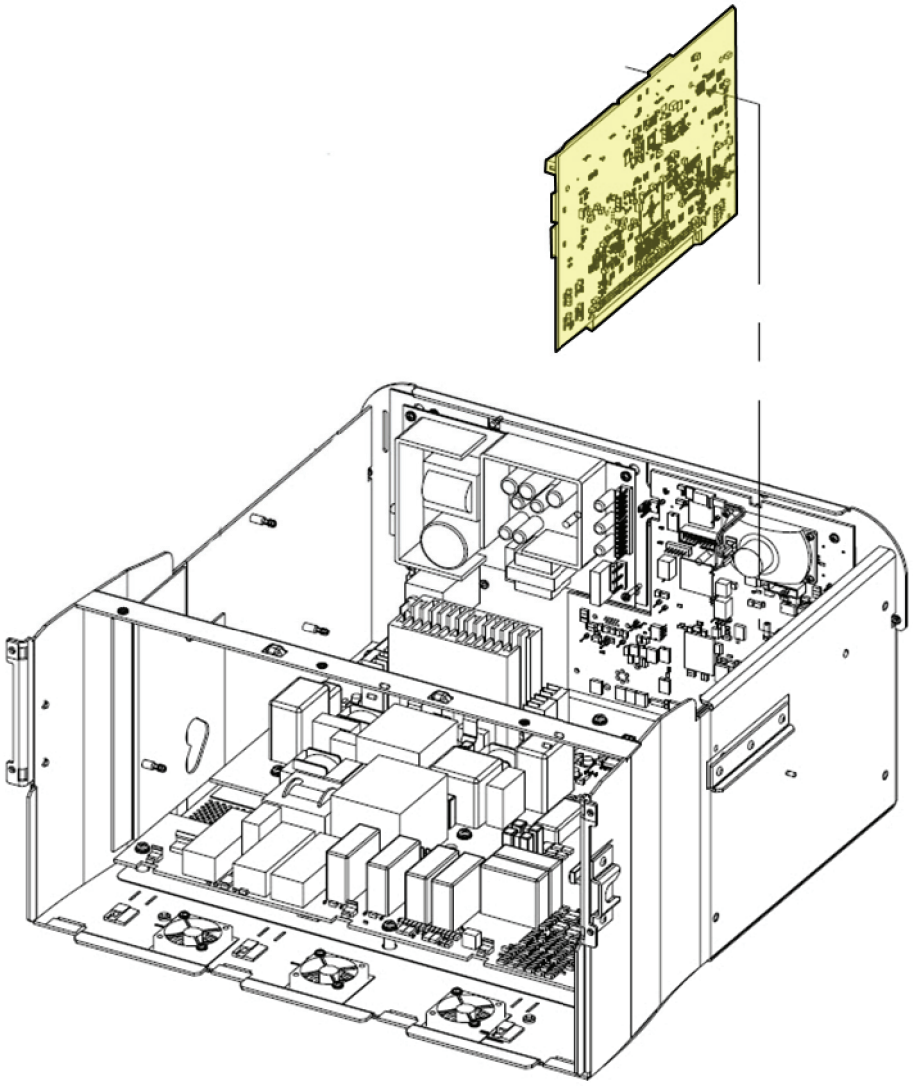
Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the Controller PCBA on the right side of the system and disconnect the cable assemblies from the Controller PCBA.
4. Remove the single screw securing the Controller PCBA to the chassis.
5. Disengage the stand-off by carefully pulling the Controller PCBA away from the chassis until the controller is free.
6. Remove the Controller PCBA, taking care not to damage the RF PCBA connector or components on the backside of the board.
7. Install the new Controller PCBA in the correct orientation, taking care to align the RF PCBA connector properly. Extreme caution should be taken when installing the board to avoid damage to the backside of the board.
8. Replace the single screw and stand-off securing the Controller PCBA to the chassis.
9. Reconnect the cable assemblies to the Controller PCBA.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
11. Perform a level-6 calibration of the system as described in *Calibration Levels* on page 6-6.
12. Retrieve the system serial number from the rear of the system. This number is required when contacting customer service.

13. Obtain a serial number packet to update the newly replaced board to match the system serial number, contact customer service at: valleylab.technicalservice@covidien.com.

14. After receiving the serial number packet, connect the system to Valleylab Exchange to ensure the latest software version is installed.

Controller PCBA



High-Voltage DC (HVDC) PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

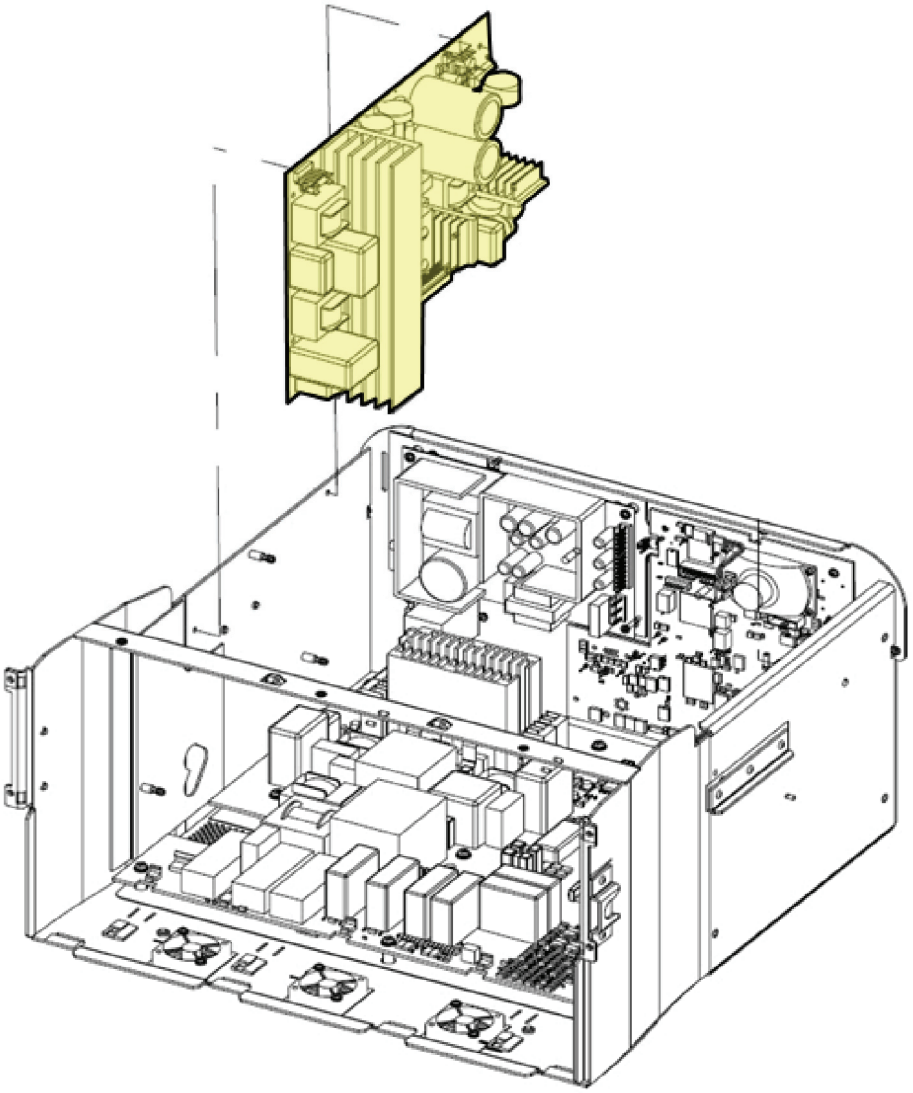
The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Locate the HVDC PCBA on the left side of the system and disconnect the cable assemblies from the HVDC PCBA.
4. Remove the screws securing the HVDC PCBA to the chassis. This screws are inserted from the chassis side of the assembly.
5. Disengage the both stand-offs by carefully pulling the controller HVDC PCBA away from the chassis until the PCBA is free.
6. Remove the HVDC PCBA, taking care not to damage the RF PCBA connector.
7. Install the new HVDC PCBA in the correct orientation, taking care to align the RF PCBA connector properly.
8. Replace the screws securing the HVDC PCBA to the chassis.
9. Reconnect the cable assemblies to the HVDC PCBA.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
11. Perform a level-4 calibration of the system as described in *Calibration Levels* on page 6-6.

High-Voltage DC (HVDC) PCBA



RF PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the following components:
   a. Controller PCBA; see *Controller PCBA Replacement* on page 8-10.
   b. HVDC PCBA; see *High-Voltage DC (HVDC) PCBA Replacement* on page 8-12.
   c. Front-panel assembly; see *Removing the Front Panel* on page 8-2.
4. Disconnect cable assemblies:
   a. Footswitch/audio PCBA to RF PCBA
   b. LVPS PCBA to RF PCBA
   c. Fan and temperature sensor
5. Remove the nine screws securing the RF PCBA to the chassis.
6. Remove the RF PCBA by lifting and sliding forward.
7. Install the new RF PCBA by lowering and sliding backwards.
8. Reinstall the nine screws securing the RF PCBA to the chassis.
9. Reconnect cable assemblies:
   a. Footswitch/audio PCBA to RF PCBA
   b. LVPS PCBA to RF PCBA

c. Fan and temperature sensor

10. Reinstall components:

a. Front-panel assembly; see *Steering-Relay PCBA Replacement* on page 8-16.

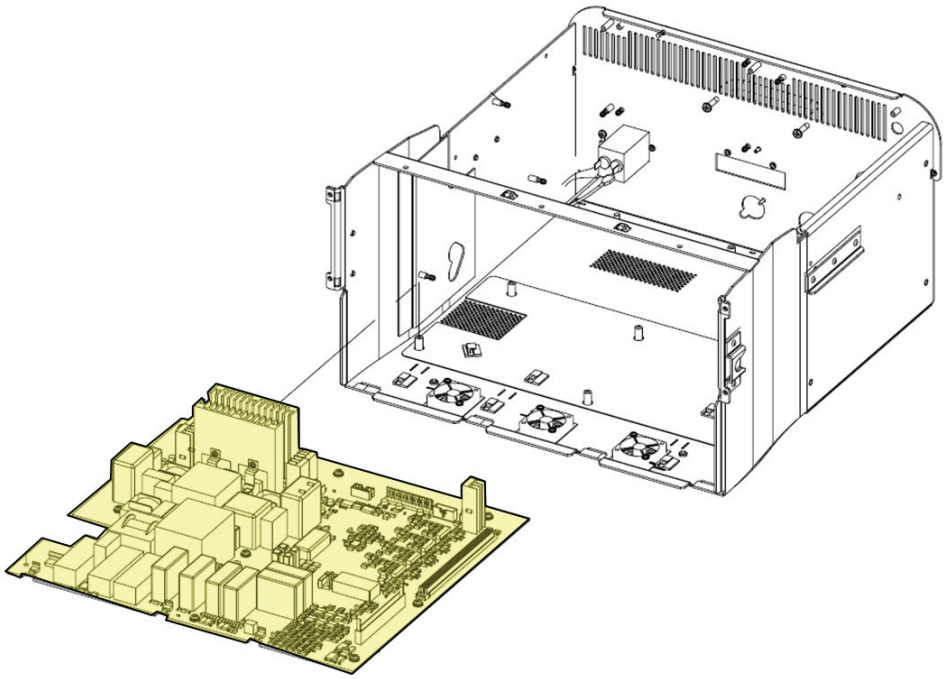
b. HVDC PCBA; see *High-Voltage DC (HVDC) PCBA Replacement* on page 8-12.

c. Controller PCBA; see *Reinstalling the Front Panel* on page 8-3.

11. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

12. Perform a level-5 calibration of the system as described in *Calibration Levels* on page 6-6.

RF PCBA



Steering-Relay PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Calibrate the system after you install a new Steering/Relay PCBA. Refer to *Calibrating the ForceTriad Energy Platform* on page 6-4 for instructions.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. With the top of the front panel facing away, disconnect the following:
   - **a.** Barcode-scanner cables
   - **b.** Connector cables from the Steering-Relay PCBA to the RF PCBA
   - **c.** Steering-Relay PCBA to Display PCBA cable assembly
3. Remove the four screws securing the Steering-Relay PCBA to the side brackets. Remove the three screws attaching the bracket to the top of the Steering-Relay PCBA.
4. Carefully lift the Steering-Relay PCBA off of the front panel until sufficient space to disconnect the cable assemblies is available. Disconnect the cable assemblies attaching the Steering-Relay PCBA to the output receptacles. Finish removing the Steering-Relay PCBA.
5. Install the new Steering-Relay PCBA:
   - **a.** Position the Steering-Relay PCBA above the front panel in the correct orientation.
   - **b.** Reconnect the cable assemblies attaching the Steering-Relay PCBA to the output receptacles.

c. Reconnect the cable assembly connecting the Steering-Relay PCBA to the Display PCBA.

d. Verify that the barcode-scanner cable assemblies are not trapped between the two assemblies.

e. Lower the Steering-Relay PCBA onto the front panel making sure the barcode-scanner assemblies align with the slots in the Steering-Relay PCBA.

6. Reinstall the four screws securing the Steering-Relay PCBA to the front panel side brackets.

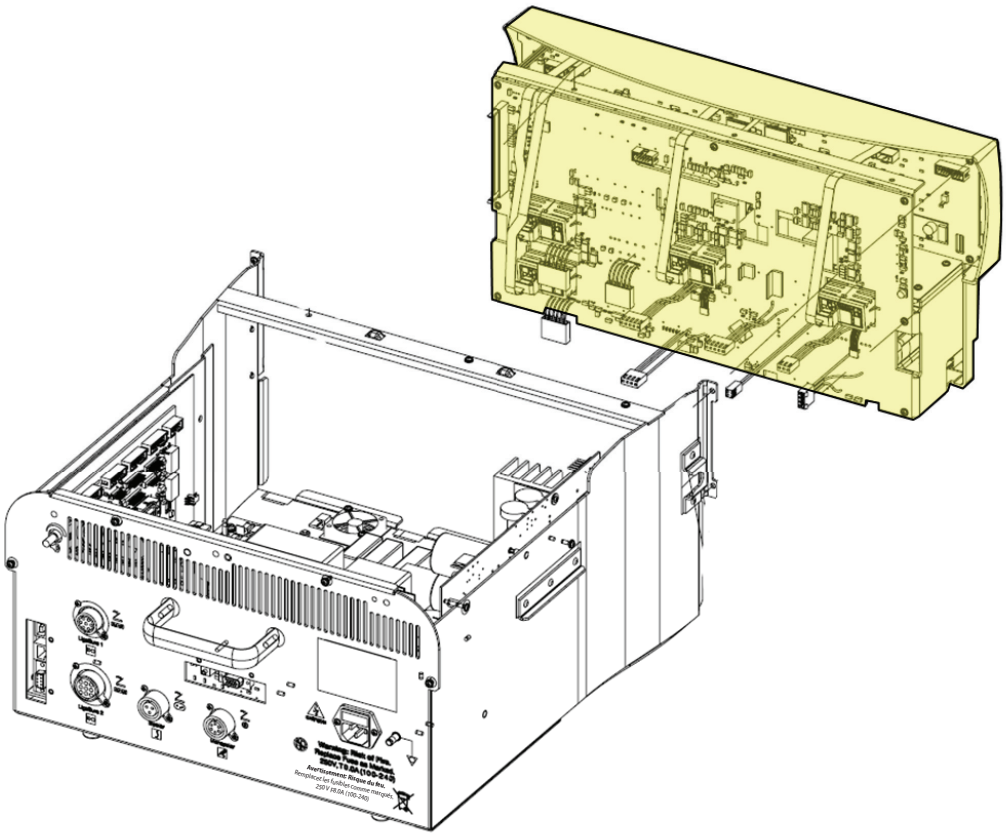
7. Reconnect the four barcode-scanner cable assemblies taking care to fully insert and align the ZIF cables. Verify the shield ground connectors are completely connected.

8. Reinstall the top bracket using three screws, verifying the barcode-scanner cable assemblies are captured in the proper slots.

9. Reinstall the front-panel assembly; see *Reinstalling the Front Panel* on page 8-3.

10. Perform a level-5 calibration of the system as described in *Calibration Levels* on page 6-6.

Steering-Relay PCBA



Display PCBA Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

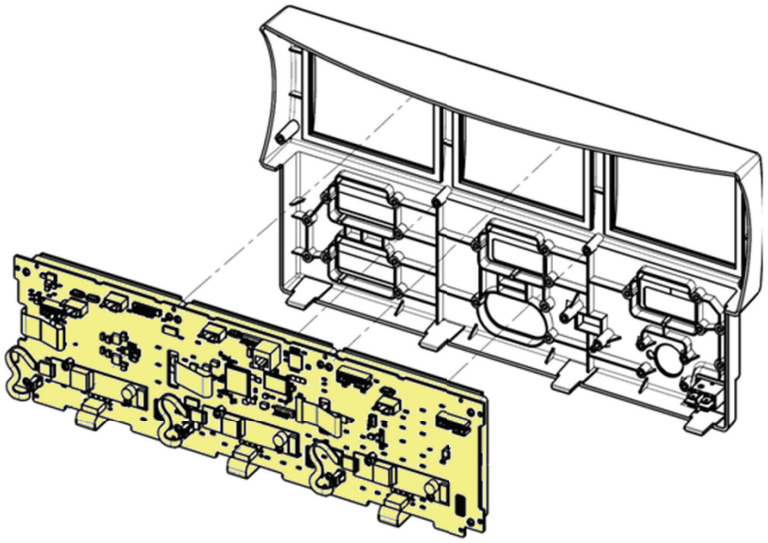
The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. Remove the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
3. Remove the four screws in the center of the Display PCBA securing it to the front panel. Carefully lift the Display PCBA out of the front panel.
4. Install the new Display PCBA by carefully lowering it into the front panel in the correct orientation.
5. Replace the four screws securing the Display PCBA to the front panel.
6. Reinstall the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
7. Reinstall the front-panel assembly; see *Reinstalling the Front Panel* on page 8-3.
8. Perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.

Display PCBA



Barcode Scanner Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

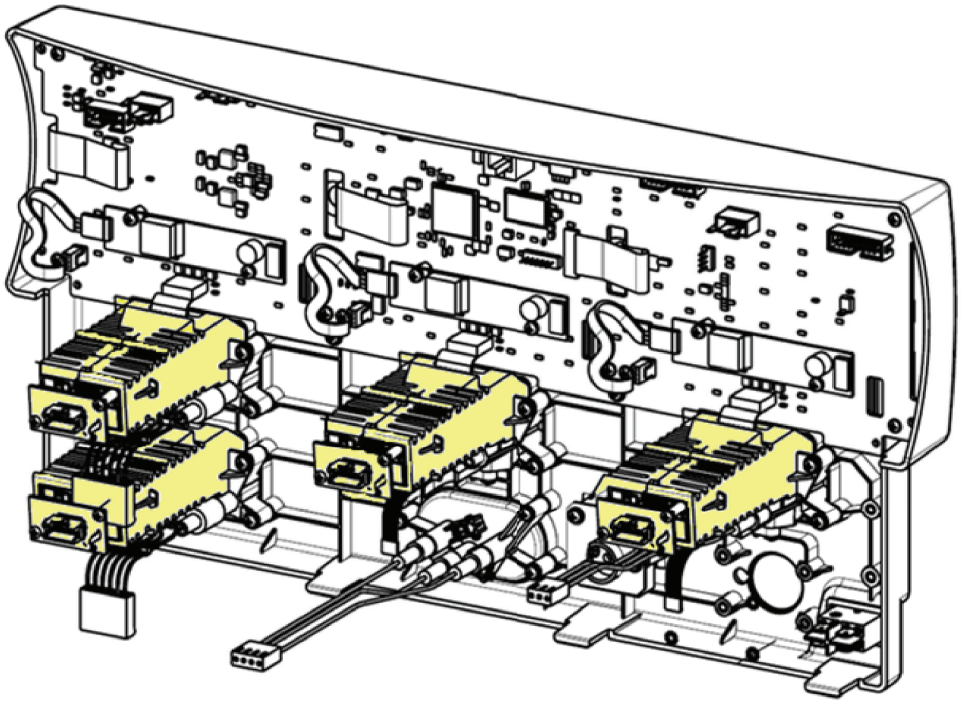
Calibrate the system after you install a new Barcode Scanner. Refer to *Calibrating the ForceTriad Energy Platform* on page 6-4 for instructions.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. Remove the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
3. Remove the two screws at the bottom of the barcode-scanner assembly. Slide the barcode scanner and shield out of the receptacle assembly.
4. Slide the new barcode scanner into the shield, ensuring the shield ground tab mates correctly.
5. Slide the barcode scanner and shield into the receptacle assembly. Reattach the two screws securing the barcode scanner to the receptacle assembly.
6. Reinstall the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
7. Reinstall the front panel; see *Reinstalling the Front Panel* on page 8-3.
8. Perform a level-1 calibration of the system as described in *Calibration Levels* on page 6-6.

Barcode Scanner



Output Receptacle Replacement

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. Remove the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.

Monopolar 1 Receptacle

a. Remove the three screws securing the Monopolar 1 receptacle to the front panel.

b. Remove the scanner shroud.

c. Install the new Monopolar 1 receptacle and scanner shrouds in the front panel using the three screws.

Monopolar 2 Receptacle

a. Remove the three screws securing the Monopolar 2 receptacle to the front panel.

b. Remove the scanner shroud.

c. Install the new Monopolar 2 receptacle and scanner shrouds in the front panel using the three screws.

LigaSure 1 Receptacle

a. Remove the three screws securing the LigaSure 1 receptacle to the front panel.

b. Remove the scanner shroud.

c. Install the new LigaSure 1 receptacle and scanner shrouds in the front panel using the three screws.

LigaSure 2 Receptacle

a. Remove the three screws securing the LigaSure 2 receptacle to the front panel.

b. Remove the scanner shroud.

c. Install the new LigaSure 2 receptacle and scanner shrouds in the front panel using the three screws.

Universal Footswitching Port

a. Remove the four screws securing the Universal Footswitching Port to the front panel.

b. Remove the UFP push button from the front of the receptacle by rotating the button counter clock-wise until the button is free.

c. Install the new Universal Footswitching Port in the front panel using the four screws.

d. Reinstall the UFP push button by rotating the button clock-wise until tight.

Bipolar Receptacle

a. Remove the three screws securing the Bipolar receptacle to the front panel.

b. Install the new Bipolar receptacle in the front panel using the three screws.

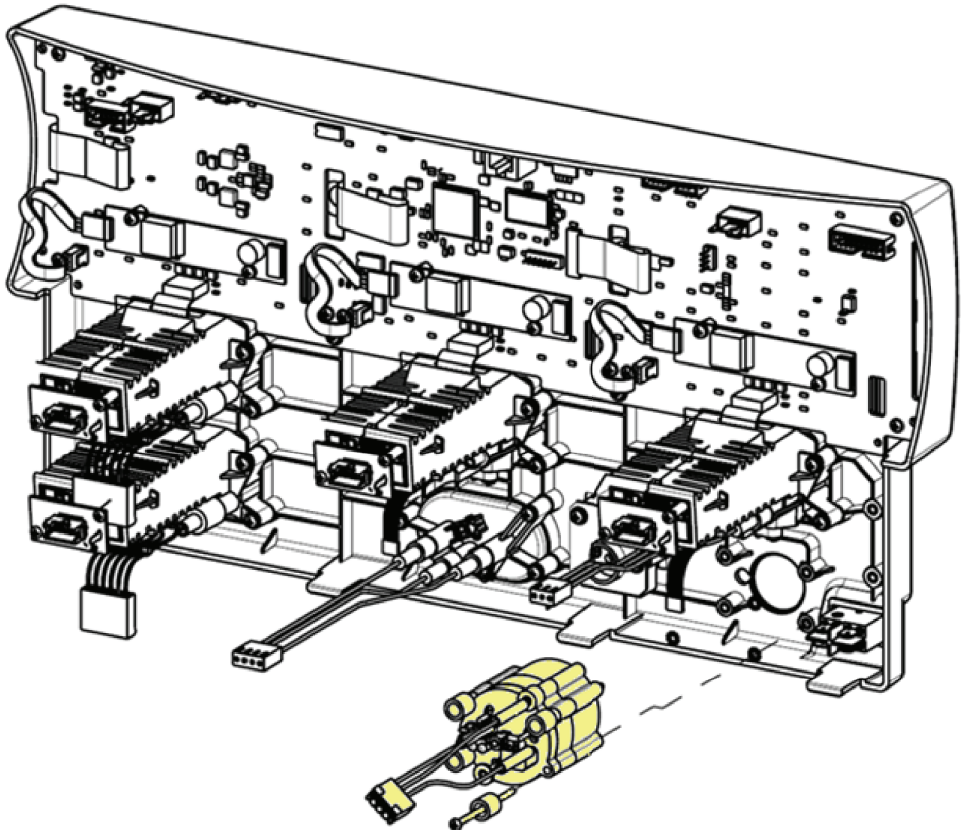
REM Receptacle

a. Remove the two screws securing the REM receptacle to the front panel. Note the length of each screw. Remove the REM retaining bracket.

b. Install the new REM receptacle in the front panel. Replace the REM retaining bracket. Secure the REM receptacle and bracket using the two screws.

3. Reinstall the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
4. Reinstall the front-panel assembly; see *Reinstalling the Front Panel* on page 8-3.
5. Perform a level-5 calibration of the system as described in *Calibration Levels* on page 6-6.

Output Receptacles



Barcode-Scanner Cables

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

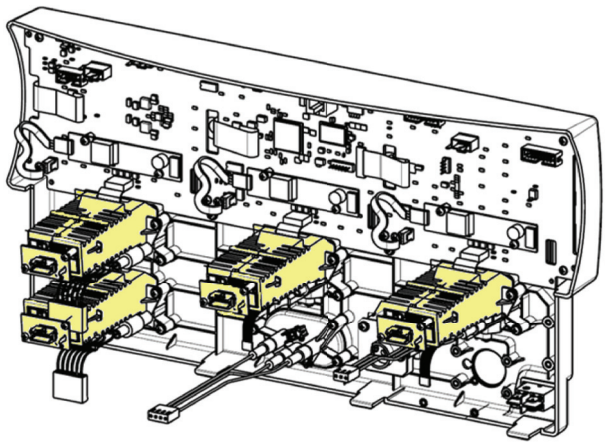
The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. With the top of the front panel facing away, disconnect the barcode-scanner cables.
3. Replace the barcode-scanner cables.
4. Reinstall the cables and front-panel assembly.
5. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
6. Perform a level-1 calibration of the system as described in *Calibration Levels* on page 6-6.

Barcode-Scanner Cables



System Displays

Equipment required:

- Phillips screwdriver
- Torque wrench

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

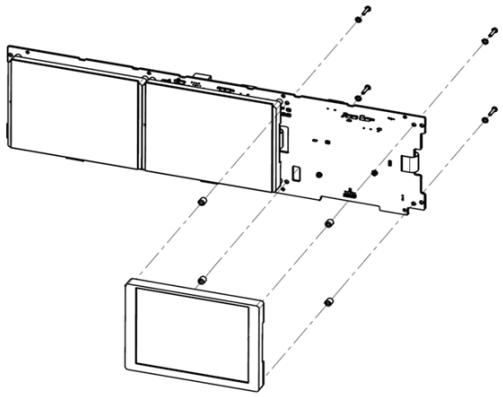
1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. With the top of the front panel facing away, disconnect the following:
   a. Barcode-scanner cables
   b. Zero Insertion Force (ZIF) connectors, if applicable, then the shield ground connectors
   c. Steering-Relay PCBA to Display PCBA cable assembly

Note: Some system configurations were equipped with Zero Insertion Force (ZIF) connectors instead of Molex-type connectors.

3. Remove the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
4. Carefully lift the Steering-Relay PCBA off the front panel until sufficient space to disconnect the cables assemblies is available. Finish removing the Steering-Relay PCBA.
5. Remove the Display PCBA; see *System Displays* on page 8-26.
6. Disconnect the ribbon cables from the LCD/touch screen to the display board.
7. Remove the four fasteners holding the LCD/touch screen to the Display PCBA, and retain the hardware, screws, washers, and spacers for use in installing the new LCD/touch screen. Repeat the process as needed for the remaining two screens.
8. Properly discard the damaged LCD/touch screens and locate the replacement components.

9. With the face of the replacement LCD/touch screen down, place the Display PCBA on top of the screen, feed the ribbon cables through their cable ways, and reconnect the four sets of fasteners. *Do not tighten*. Leave these fasteners loose; they will be tightened in a later step.
10. Reconnect the ribbon cables to the LCD/touch screen. If new cables were provided with the spare component or cables were damaged during service, replace the existing cables.
11. To help with screen alignment, loosen the remaining screws for all three screens. *Do not completely remove them*. This will allow for movement when reinstalling the Display PCBA into the front panel.
12. To realigning the screens, place the Display PCBA face down into the front bezel (panel). Ensure the foam gaskets affixed to the screens make contact to the bezel and forms a seal. Install the bottom of the Display PCBA into the bezel first, then slowly position or rotate the top of the Display PCBA into place.
13. With the Display PCBA in place in the front bezel, fully tighten the twelve screws that secure the three LCD/touch screens to the Display PCBA. Tighten to a torque of 6 in-lbs., +/- 0.5 in-lbs. beginning with the four center crews that secure the middle screen.
14. Inspect for alignment issues by looking at the front of the front-panel assembly. If any LCD/touch screens looks crooked, loosen the screws for that screen and the four center screen screws, and re-align and retighten.
15. Reassemble the new or repaired Display PCBA to the front bezel using the screws and wasters that were previously removed. Tighten these screws to a torque of 3 in.-lb. Only install the four center screws. Install the other four outside screws later when the front panel is assembled to the chassis.
16. Reinstall the steering relay and front-panel assembly.
17. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
18. Perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.

System Display



System Display Cables

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

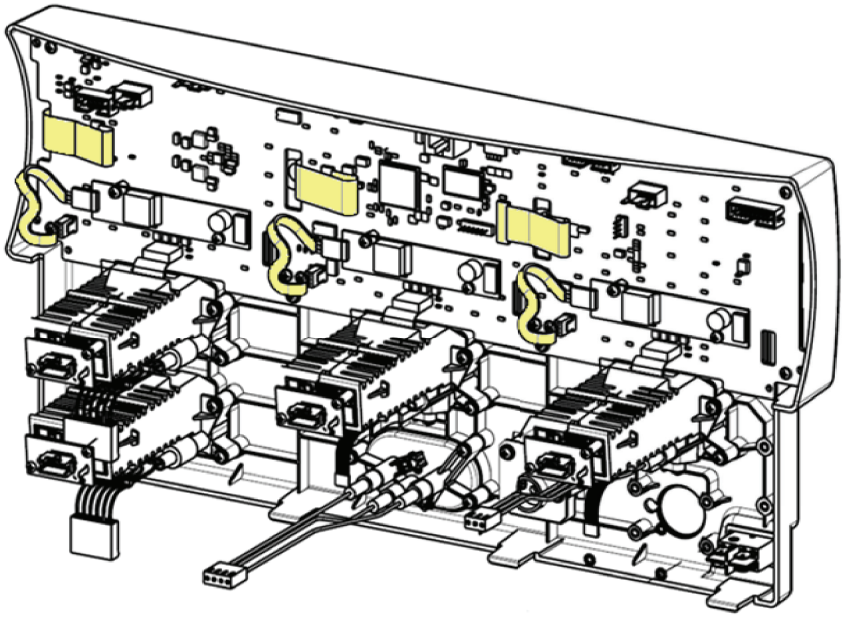
Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Remove the front-panel assembly; see *Removing the Front Panel* on page 8-2.
2. With the top of the front panel facing away, disconnect the following:
   a. Barcode-scanner cables
   b. Zero Insertion Force (ZIF) connectors, if applicable, then the shield ground connectors
   c. Steering-Relay PCBA to Display PCBA cable assembly
3. Remove the Steering-Relay PCBA; see *Steering-Relay PCBA Replacement* on page 8-16.
4. Carefully lift the Steering-Relay PCBA off the front panel until sufficient space to disconnect the cables assemblies is available. Finish removing the Steering-Relay PCBA.
5. Remove the Display PCBA; see *System Displays* on page 8-26.
6. Remove the retaining screws from each of the three LCD screens to gain access to the display cables.
7. Disconnect the ribbon cables from the LCD/touch screen to the display board.
8. Replace the cables and reconnect them to the LCD/touch screen.
9. Reinstall the steering relay and front-panel assembly.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.

11. Perform a level-3 calibration of the system as described in *Calibration Levels* on page 6-6.

System Display Cables



System Fans

Equipment required:

- Phillips screwdriver

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Remove the four screws that secure the cover to the chassis. Slide the cover off the chassis. Set the cover and screws aside for reinstallation.
3. Remove the following components:

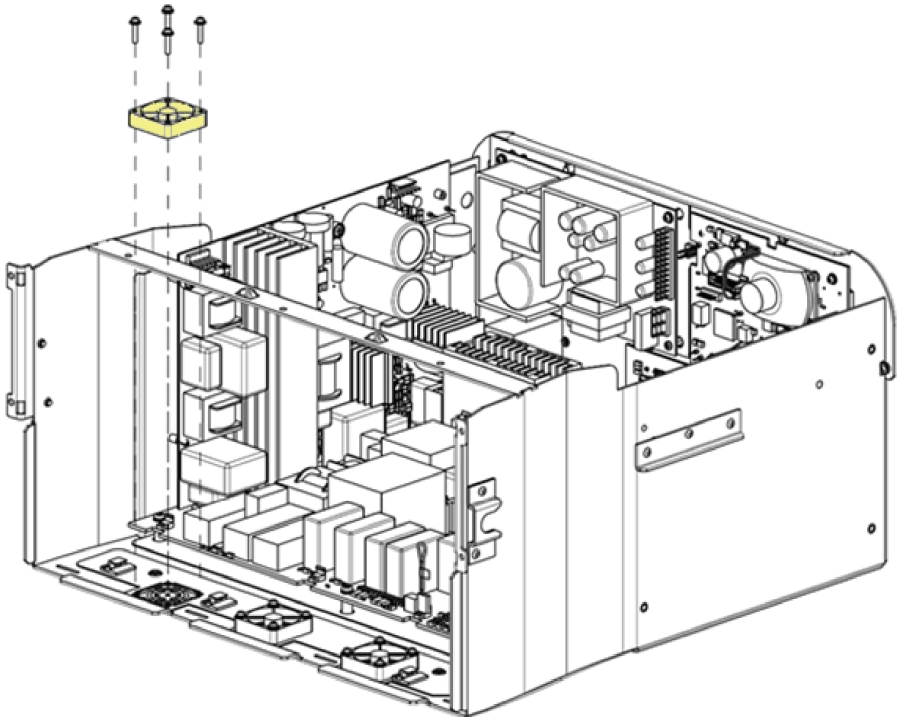
   a. Controller PCBA; see *Controller PCBA Replacement* on page 8-10.

   b. HVDC PCBA; see *High-Voltage DC (HVDC) PCBA Replacement* on page 8-12.

   c. front-panel assembly; see *Removing the Front Panel* on page 8-2.
4. Disconnect the cable assemblies for the Footswitch PCBA, LVPS, system fans, and temperature switch.
5. Remove the nine screws securing the RF PCBA to the chassis.
6. Remove the RF PCBA by lifting and moving the PCBA forward.
7. Remove the four fasteners holding the fans to the chassis.
8. Remove and replace the defective fans.
9. Reinstall the RF PCBA, Controller PCBA, HVDC PCBA, and front-panel assembly.

   Note: Ensure the fan cabling is routed properly to avoid damage to the system fans' wire harness. Damage to the wire harness can lead to poor or disabled fan operation.
10. Position the cover above the chassis and slide it down. Install the four screws that secure the cover to the chassis.
11. Perform a level 0 calibration of the system as described in *Calibration Levels* on page 6-6.

System Fans



Scan Stand Label

Equipment required:

- Phillips screwdriver
- Exacto™ Knife

Warning

Electric Shock Hazard To allow stored energy to dissipate after power is disconnected, wait at least five minutes before replacing parts.

Caution

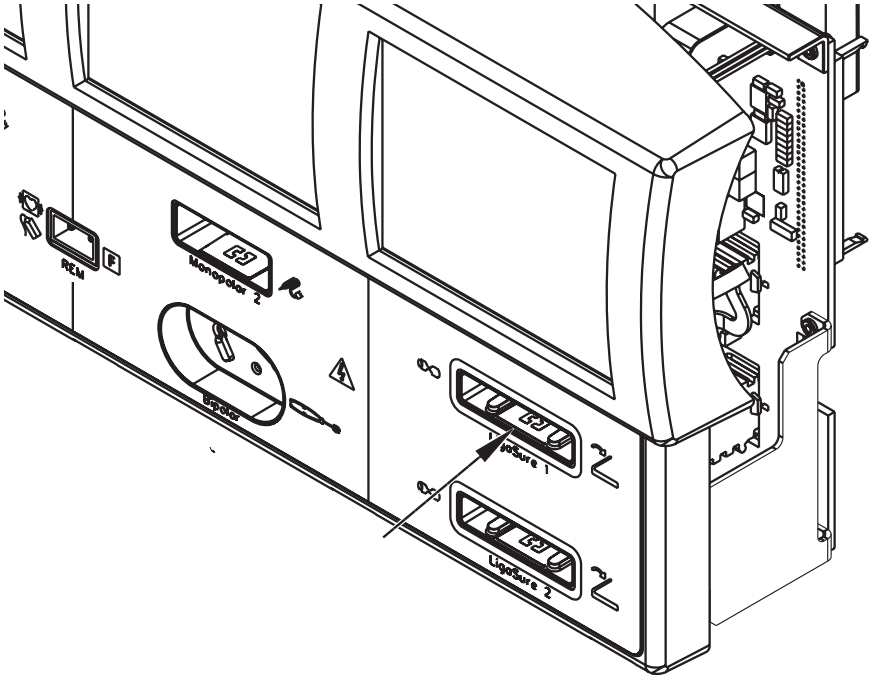
The system contains electrostatic-sensitive components. When repairing the system, work at a static-control workstation. Wear a grounding strap when handling electrostatic-sensitive components, except when working on an energized system. Handle PCBAs by their non-conductive edges. Use an antistatic container for transport of electrostatic-sensitive components and PCBAs.

Notice

Perform all the steps including the recalibration listed below. Failure to recalibrate the system after replacing components may result in the system becoming inoperable.

1. Turn off the system. Disconnect the power cord from the wall receptacle.
2. Using the Exacto knife, remove the label from the receptacle taking care not to scratch the plastic housing.
3. After removal, clean the scan stand label surface with alcohol or other solvent.
4. Allow the plastic housing to dry completely.
5. Install the new scan stand label into the receptacle ensuring that it is centered within the indentations on the scan stand. Indentations vary between revision levels of the system.
6. Perform a level-1 calibration of the system as described in *Calibration Levels* on page 6-6.

Scan Stand Label



Chapter 9

Maintenance and Repair

This chapter presents the following information:

- The manufacturer's responsibility
- Routine maintenance
- Returning the system for service
- Service centers

Caution
Read all warnings, cautions, and instructions provided with this system before use.
Read the instructions, warnings, and cautions provided with electrosurgical instruments before use. Specific instructions for electrosurgical instruments are not included in this manual.

Responsibility of the Manufacturer

Covidien is responsible for the safety, reliability, and performance of the system only if all of the following conditions have been met:

- Installation and set-up procedures in this manual are followed.
- Assembly, operation, readjustments, modifications, or repairs are carried out by qualified personnel only.
- The electrical installation of the relevant room complies with local codes and regulatory requirements, such as IEC and BSI.
- The equipment is used in accordance with the instructions for use.

For warranty information, refer to the *Limited Warranty* in this manual.

Routine Maintenance and Periodic Safety Checks

When should the system be checked or serviced?

Covidien recommends that at least once a year, qualified service personnel inspect the system and conduct periodic safety checks. This inspection should include adjusting the system to factory specifications.

When should the power cord be checked or replaced?

Check the power cord before each use of the system or at the intervals recommended by your institution. Check the power cord for exposed wires, cracks, frayed edges, or a damaged connector. Replace damaged cords.

When should the fuses be replaced?

An internal component malfunction can damage the fuses. The system fuses may need to be replaced if the system fails the self-test or if the system stops functioning, even though it is receiving power from a wall outlet. Refer to *Fuse Replacement* on page 8-4 for instructions.

Cleaning

Warning

Electric Shock Hazard Always turn off and unplug the system before cleaning.

Notice

Do not clean the system with abrasive cleaning or disinfectant compounds, solvents, or other materials that could scratch the panels or damage the system.

1. Turn off the system and unplug the power cord from the wall outlet.
2. Thoroughly wipe all surfaces of the system and power cord with a damp cloth and mild cleaning solution or disinfectant. The system will withstand the effects of cleaning over time without degrading the enclosure or display quality.

Product Service

Covidien recommends that all ForceTriad systems be returned to the manufacturer for all service requirements. If any service is required without returning the system to the manufacturer, Covidien recommends that only qualified personnel service the ForceTriad system.

Covidien defines qualified personnel as a person with electrosurgical equipment repair experience, such as biomedical personnel, and/or individuals who have taken official Covidien training courses.

Returning the System for Service

Before returning the system, call a Covidien sales representative for assistance. If instructed to send the system to Covidien, do the following:

1. Obtain a return authorization number.

   Call the Covidien Technical Service (see page 9-4) to obtain a Return Authorization Number. Have the following information ready before the call:

   – Hospital/clinic name/customer number
   – Telephone number
   – Department/address, city, state, and zip code
   – Model number
   – Serial number
   – Description of the problem
   – Type of repair to be done

2. Clean the system.
   See the *Cleaning* section above.

3. Ship the system.
   a. Attach a tag to the system that includes the return authorization number and the information (hospital, phone number, etc.) listed in step 1.
   b. Be sure the system is completely dry before packing it for shipment. Package it in its original shipping container, if available.
   c. Ship the system, prepaid, to the Covidien Service Center.

Adjustment to Factory Specification (Calibration)

Covidien recommends that only qualified personnel calibrate the system. The system incorporates automatic calibration where possible to reduce the required equipment and manual steps.

Software Upgrades

Software upgrades must be performed by authorized personnel only.

Covidien Technical Service

For service, contact Covidien Technical Service or your ForceTriad sales representative. Contact a Covidien technical service representative by telephone, email, or through the Internet:

- USA and Canada: 1-800-255-8522 Option 2
- International: 1-303-476-7996
- Email: valleylab.technicalservice@covidien.com
- Internet: www.forcetriad.com

For a complete list of service centers worldwide, please refer to the Covidien web site:

http://www.valleylab.com

Chapter 10

Service Parts

Replacement parts for the ForceTriad energy platform are listed in this chapter. All components must be replaced with parts of identical construction and value acquired from Covidien Customer Service Centers. Covidien does not recommend nor supply components for field replacement of surface-mount components. Only PCBA level changes should occur in the field.

Ordering Replacement Parts

Parts may be ordered from the Covidien Customer Service for your location.

When ordering replacement parts, include this information:

- Model number (located on the rear panel of the system)
- Serial number (located on the rear panel of the system)
- Part description (Controller PCBA, System Fan, etc.)

  Part numbers are not listed because system configuration information is required to supply the correct revision or part number of the replacement component.
- System configuration

  Use the system menus to identify the system configuration. Main Menu -> Service -> Configuration.

  – ICL FPGA

  – RF PCBA

  – Steering Relay PCBA

  – HVDC PCBA

  – Display PCBA

  – Footswitch PCBA

  – Controller PCBA

  – Software build version

If the information cannot be obtained, contact Covidien Technical Service (see page 9-4).

Replacement Components

Refer to Chapter 8, *Replacement Procedures* for step-by-step instructions for the removal of the referenced components.

Caution

Take proper ESD precautions when handling and replacing components. Irreversible damage may occur due to static transfer if the component is handled improperly.

The following printed circuit board assemblies (PCBA) can be replaced:

- Controller PCBA
- RF PCBA
- HVDC PCBA
- Steering Relay PCBA
- FTSW PCBA
- Display PCBA

The following system components can be replaced:

- Barcode scanner
- System display
- LVPS
- System fans
- Scan stand label
- Front panel assembly

Replacing Cable Assemblies

The complete wiring schematic is at the beginning of Chapter 3, *Principles of Operation*. Refer to the schematic for location of the cable assemblies.

Block Diagram key to numbers

1 ASSY CABLE CHASSIS-GND NHP	23 CABLE DISPLAY POWER FORCETRIAD
2 CABLE AC FILTER-SWITCH FORCETRIAD	24 CABLE UFAP SENSE FORCETRIAD
3 CABLE PANEL-SWITCH FORCETRIAD	25 CABLE ETHERNET 27 INCH
4 CABLE AC SWITCH HVDC FORCETRIAD	26 CABLE FLEX LCD-DISPLAY FORCETRIAD
5 CABLE HVDC-LVPS FORCETRIAD	27 CABLE FLEX LCD-DISPLAY FORCETRIAD
6 CABLE RF-LVPS FORCETRIAD	28 CABLE FLEX LCD-DISPLAY FORCETRIAD
7 CABLE SPEAKER FORCETRIAD	29 CABLE LCD-INVERTER FORCETRIAD
8 CABLE LIGASURE 1 FTSW FORCETRIAD	30 CABLE LCD-INVERTER FORCETRIAD
9 CABLE LIGASURE 2 FTSW FORCETRIAD	31 CABLE LCD-INVERTER FORCETRIAD
10 CABLE REM SR-RF FORCETRIAD	32 CABLE RIBBON SCANNER FORCETRIAD (LIG 1)
11 CABLE MONO OUT FORCETRIAD	33 CABLE RIBBON SCANNER FORCETRIAD (LIG 2)
12 CABLE RF-STEERING FORCETRIAD	34 CABLE RIBBON SCANNER FORCETRIAD (MONO 1)
13 CABLE AUTOBIPOLAR FORCETRIAD	35 CABLE RIBBON SCANNER FORCETRIAD (LIG 2)
14 CABLE LIG 1 OUTPUT FORCETRIAD	36 INTEGRAL TO LCD ASSEMBLY
15 CABLE LIG 2 OUTPUT FORCETRIAD	37 INTEGRAL TO LCD ASSEMBLY
16 CABLE BIP OUTPUT FORCETRIAD	38 INTEGRAL TO LCD ASSEMBLY
17 CABLE BIPOLAR SENSE FORCETRIAD	39 CABLE UFP POWER FORCETRAID
18 CABLE ACTIVE BIPOLAR SENSE	40 ASSY CABLE REM RETURN FORCETRIAD
19 CABLE MONO 1 OUTPUT	41 CABLE RF-FOOTSWITCH FORCETRIAD
20 CABLE MONO 2 OUTPUT	42 CABLE RF SHIELD FORCETRIAD
21 CABLE DISPLAY POWER	43 not orderable
22 CABLE MONO MODE FORCETRIAD	44 JUMPER CABLE FAN FEP

Consult instructions for use

Part No. 1040472

U.S. Patents 5,370,645; 5,372,596; 5,772,659; 6,068,627; 6,203,541; 7,137,980; 7,722,601; 7,416,437; 7,513,896; 7,648,499; 7,651,492; 7,766,693; 7,901,400; D567,761; D574,323.

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Covidien llc, 15 Hampshire Street,
Mansfield, MA 02048 USA.

EC REP Covidien Ireland Limited,
IDA Business & Technology Park, Tullamore.

www.covidien.com

1-303-530-2300 [T]
1-800-255-8522 [T]

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